THE PRINCIPLES OF AGRICULTURE

THROUGH THE

SCHOOL AND THE HOME GARDEN

BY

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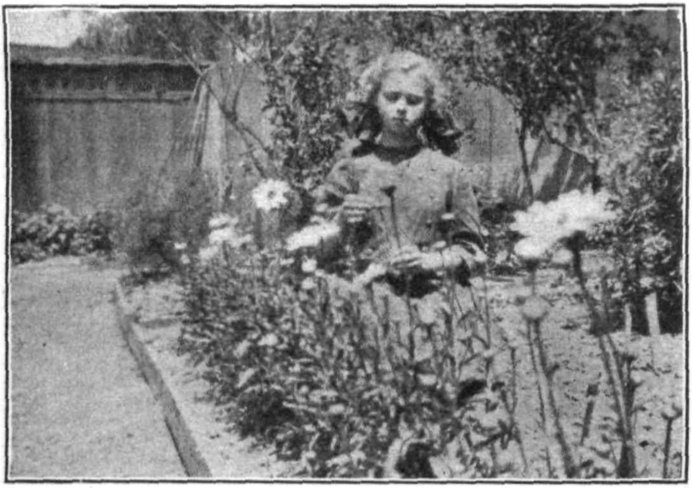
TO one who ever realized her ideal of self-sacrifice, who was ever patient through the long watches, who ever served most where few could see, this book is dedicated.



DAISIES GROWING A GIRL.

PREFACE

TIME was when the education of the boy and the girl rested with the church, the home, the farm, and the school. Gradually the church, the home, and the farm have shifted their educational responsibilities upon the school. The teaching of morals, home economics, domestic science, has been added to an already unwieldy curriculum. Now the state is insisting that the school help in raising the ideals of the farm.

With the many insistent demands upon the school and its widening responsibilities, it needs the sympathy, not the adverse criticism of its adherents; it needs constructive optimism, not destructive pessimism. In the evolutionary outreaching of the school, the time is coming when it will embrace the farm, the home, and the church. The school, then, will not be confined to buildings at the corner of X and Y streets with a few teachers, but it will constitute the whole community, and each and every one will be teachers.

To this end the school and the home garden may function. The garden may be used as a means to an end; namely, to unite school and community life.

The boy of the rural district knows little of country life beyond its drudgery; the city boy knows little of the life of the city, and both know little of world problems. The garden may be used as a factor to point towards the problems of each community and the state. For example, sugar beet raising in the garden, and the subsequent process in extracting sugar, are a part of the activities of many communities. It is a short step from the class process to the business man's process, to the work of the world in supplying its people with sugar. Again, capillary action that works in a tube of soil in the classroom is the same force at work in the garden and on the farm, of which the gardener and the farmer must in a like manner take cognizance. Thus the garden may be used not only to point towards the activities of the state, but the child takes part in these activities at school.

The old subjects in the curriculum in many instances may be given new content, new direction. Geography, hygiene, arithmetic, manual training, art, etc., may be vitalized. The problem which is free from the coloring of a textbook and which arises in life, is often too much for the pupil. The mechanics of the school work adapts him in time to textbook situations, but does not make him easily adjustable to the shifting circumstances of life outside of the school.

It is with this point of view in mind that the author hopes the teacher will use this text — to use the garden, not for the sake of the garden itself, but that it may lead the children into the life of the state. It is the sincere wish of the writer that this little book may be of use in furthering the progress of the school.

INTRODUCTION

In this country, the first steps looking toward a comprehensive study of Agriculture, and toward educational training in the use of the processes of Agriculture, were taken in the campaign of the early 60's that ended in the great Congressional Land Grant Act of 1862. Colleges and other higher institutions were established or reorganized for instruction in Agriculture and the Mechanic Arts, independently of, or in conjunction with, "other scientific and classical studies." In sixty-eight such institutions there are to-day seventy-five thousand students and an investment of one hundred and twenty million dollars, with an annual income of over twenty million dollars.

The unquestioned success of these efforts at education in the subjects that pertain to the industrial life has borne fruit in an aggressive movement for the establishment of a system of secondary schools that shall give instruction in the manual and industrial arts — agriculture, mechanics, the household arts, and the elements of technology. In both public high schools and private or independent manual training schools, numbering more than two thousand institu-

tions, there are enrolled over one hundred and twenty-five thousand students following longer or shorter courses in such industrial subjects. This includes more than one thousand schools reporting forty thousand pupils pursuing courses in Agriculture. There has already accumulated a respectable body of literature upon Agriculture and related subjects suited to the maturity and attainments of boys and girls of fourteen to eighteen years of age. Courses have been outlined, methods of handling materials are being worked out, and some progress made in relating instruction in these subjects to that in the humanistic and other traditional branches. Agricultural high schools and Agricultural Courses in the established secondary schools have won a first but enduring recognition.

Yet the colleges and the secondary schools together reach a relatively small number of the twenty million youth eligible to receive the education which it is society's function to provide. Approximately ninety per cent receive less than a high school training; and, of these, seventy-five per cent live under town, village, or rural conditions, about whose homes the predominant occupations relate to farming or some cognate industry. Except sporadic attempts at "nature study," little has been accomplished or undertaken in the orderly use of soil, plant and animal studies for this large majority of children

to whom such studies are vital; for the several millions of elementary pupils, most of whom never reach the high school.

This need it is the purpose of Professor Stebbins' book to meet: "The Principles of Agriculture through the School and the Home Garden." It seems admirably adapted for use, either in centers of population, from cities to villages, or in rural districts, for children eleven to fifteen years of age, wherever individual or school plats, or larger tracts of ground may be had for cultivation under the direction of a teacher. Indeed, the exercises are so clear, and the explanations and figures so obvious, that any intelligent, interested child of the ages named might find the text usable almost without further guidance.

The "problem questions" and "home studies," and conditions of profitable marketing, the instructions concerning the forming of agricultural clubs, and the plan and purposes of the Boys and Girls' Junior Garden Club, must prove both interesting and helpful to early adolescents as well as to children, and suggestive to parents who are solicitous to cultivate in their children habits of intelligent industry and efficiency.

The lists of "free bulletins," also, and the "flower calendar" will be found not less helpful to adults than to youth; to the home, than to the school; to teachers, than to pupils. The method of the book is far removed from merely dogmatic instruction. Pu-

pils are challenged to experiment, test, and reason. The experiments are simple, and easily conclusive even to the limited powers and experiences of children. The apparatus is limited and inexpensive. The language is direct and very evidently has the children in mind. The author, from his present position and from his past experience, has had exceptional opportunities to know what should and should not be expected from the pupils of upper elementary schools, both in personal interest and capacity for earnest intellectual effort. The book must be classed among pioneers in industrial and educational guidance through the study of principles and typical processes in soil, soil cultivation, and soil products.

The educational doctrine of the book is sound. Such training in industry tends to give dignity to every honorable and profitable occupation. By connecting the learning of the schools with the farm and the household, not only is one's education made more serviceable, but public confidence in the schools is enhanced. While intelligent, industrial habits are being fixed, the constant reference to contributing literature and the underlying related science in its simple applications, furthers wide interests and a love of all real learning. Books alone cannot educate one, nor exercises of the hand. In Professor Stebbins' text the two are admirably combined. The pupil is constantly stimulated to read about what he

is doing, to do, in his school or home garden what he has read about, and to observe what others are doing that is well done. The book is believed to be a helpful pioneer attempt to reach some millions of children with wholesome first-hand studies in a field of most interesting material.

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TO TEACHERS

THE plan of the text in its direct relation to agriculture is to teach PRINCIPLES AND A KNOWLEDGE OF PROCESSES, not TECHNICAL MATTER. When insects attack the garden plants, there are a few fundamental principles which must be known in order to control the pests: (1) To determine, under ordinary circumstances, whether the insect, if found exposed on the plant's surface, has a biting or a sucking mouthpart. This is made known by the appearance of the plant attacked, or by an examination of the insect. (2) To know that an insect with biting mouthparts must be destroyed ordinarily by a stomach or arsenical poison, the poison to be applied to the plant. (3) To know that the insect with a sucking mouthpart must be sprayed directly. The elementary school is not the place to teach facts regarding the Plum Curculio, the Grape Phylloxera, the Pear-tree Girdler, the Woolly Aphis, etc., unless they are met in the children's gardens. Technical facts are soon forgotten, but principles, if understood, constitute a basis for individual adjustment in all new situations. Often, however, the home studies may point to an insect worthy of study if it is a

material factor in the development of the community, or is of particular interest.

The lessons are planned, (1) to teach by experiment in the classroom, or in the field, a definite principle; for example, capillary action in soils; (2) to have the children meet this principle at work in the garden that they may take advantage of it and let it direct their conduct as to cultivation, etc.; (3) to lead the children to see the method used by the farmer in utilizing this principle for his benefit, thus getting in touch with the community life. Thus the garden may ever point toward the work of the community.

Children are vitally alive, as emphasized by the little girl who said, "Oh, let's do something if we only boil water." This text is presented to the schools to feature the "do something" spirit. The experiments should be performed, but the garden should be the ultimate basis of operation. It is quite necessary for the best work that the prospective gardener know something regarding the preparation of a seed bed, and a few principles relative to the planting of seeds before operations are begun. Growers have too long been farming by rote. The first six chapters teach such principles through classroom experimentation.

The amount of time to devote to "home studies" should be determined (1) by the interest of the chil-

dren and (2) by the value of the study in directing conduct.

Insect pests levied a tax on the United States during a recent year of one billion one hundred and ninety-five million dollars. During a past year, in one state alone, wheat smut cost the farmer one million dollars, and the bitter rot of the apple, ten million dollars. There is enough information conserved in the Agricultural Colleges of the United States, if it were made use of by the people, to save this immense waste. Each rural school particularly should be of use in bringing to the country people some of this accumulated knowledge. The children should be taught the sources of expert work by sending for the bulletins which are listed in the lessons. But, the boys and girls should not only be taught how to make one acre produce, in the near future, as much as five at present; they should learn how to market the productions profitably. Therefore, the chapter on "marketing" has reason for being. The road of the potato, from the farm to the consumer, is too long and too diversified.

Many school texts, arithmetics, geographies, histories, and the like, are filled with crystallized non-essentials. The measurement of a teacher is her power of perspective in eliminating these non-essentials. The series of reviews is an attempt to focus the attention on the material which, to the writer, is most worth while.

All the lessons are not planned to be given consecutively. Insects, birds, etc., should be studied as they are met in the activities in the garden. The teacher should use her good judgment in the selection of material. Children's plant-growing contests give great momentum to the garden interest. The chapters on sweetpeas, corn, wheat, potatoes, etc., are inserted to satisfy such a plan of procedure. Poultry and pigeon raising has been successfully carried on in the schools of some states: hence the chapters on the same.

The text has been planned for use in the upper four grades. If two hours a week are given to agricultural education, spend one hour in the preparation of the experiments and the presentation of the lesson. Have the pupils prepare the exercises. For seat work assign the lesson in the text which reviews the subject matter given in the lesson as presented in class. Devote the second hour to a recitation on the subject matter and the home studies. Actual gardening may take place at recess, after and before school, or at the regular school hour assigned to this study. Be sure that the principles which are studied in the classroom direct the conduct of the children in garden work. *Sacrifice the schoolroom work in this subject for the gardening if the gardens need attention.* If the home studies and the Farmers' Bulletins are utilized, the fifth and sixth grades can well study the first sixteen

chapters and Chapters XXVI and XXVII, if they are needed. Complete the book in the later grades. Keep the gardens under way at all times if the weather permits, using the text as the need is felt. Read Chapter XVII, form agricultural clubs, and intensify the work of the upper grades. In so far as possible, weave the material as outlined in the text into the school work as a whole. A term's work in General Science may well be given in the eighth grade. See Chapter XXXIV.

Do not let such matters as an expensive fence, high-priced tools, long vacations, lack of ground, etc., prevent gardening. Get along without the fence. A radish more or less will cut no figure. The development of the boy, not the radish, is the main issue. Tools may be brought from home. Many vegetables and flowers will grow through the summer with little attention. Each vacant plot and each backyard is a possible garden and farm. If the school garden is impracticable, emphasize the home garden. However, the steps in preparing a seed bed, the planting of seeds, etc., should be demonstrated first by the teacher on a small plat at school.

Lastly, let us not teach arithmetic or agriculture for their own sake alone, but also for the sake of the larger things beyond; let us not build a course of study for anything but the sake of the boy; let us even see beyond the boy himself to consider not him

alone, but also his neighbor; with this viewpoint, the *common-school* boy and his neighbor, let us widen our perspective — the *common-school* boy, for each *common-school* boy is great. Let us not forget that Washington and Lincoln were boys; that Joan of Arc and Jane Addams were girls, and that every boy and every girl is a possible Lincoln and a possible Joan of Arc.

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C. A. STEBBINS.

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THE PRINCIPLES OF
AGRICULTURE THROUGH THE SCHOOL AND
THE HOME GARDEN

THE PRINCIPLES OF AGRICULTURE THROUGH THE SCHOOL AND THE HOME GARDEN

CHAPTER I

THE SOIL[1]

EXERCISES

All exercises should be performed either at school or at home.

1. Place in a medium-sized bottle a small amount of garden soil. Add water until the bottle is nearly filled. Shake well and set aside.

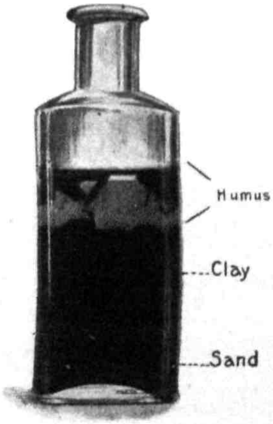

FIG. 1.

2. Examine closely samples of clay and sand. Roll each about and feel both. Note the size of the particles.

3. Secure a sample of garden soil. Note the pieces of decaying leaves and other vegetable matter. Heat over a flame a small tin of garden soil. Note the burning and the odor.

4. Place moistened samples of sand, clay, and garden soil in

[1] TO TEACHER. It may be advisable to assign Chapter VII at once and set the children to gardening. See introduction.

boxes. Insert a thermometer in each box. Note temperatures a few hours later.

5. Select two tubes each about seven inches long and one inch in diameter. Close one end of each with netting. Fill one partly full of sand and fill the other to the same height with an equal amount of clay. Arrange as shown in Fig. 4*b*. Add the same amount of water to each tube very carefully until the water drips through. Note which tube has taken up the more water. From this determine which has the more air, or pore space.

What soil is. Do you know what soil is? A great many children and a great many fathers and mothers think that soil is merely "dirt"; dirt which has to be washed from hands and faces and which seems so much in the way. But soil is more than this. It is filled with little plants and animals, and many wonderful things take place in the soil. It is a great factory and storehouse where material is made and stored away.

Look about you. The iron and lumber came from the soil. The linen out of which the girls' dresses are made came from the soil. Glass is made of soil substances. It is made of sand, which is a part of the soil. Ask your teacher to tell you how linen and glass are made. The soil furnishes much that you need to make you comfortable and happy.

Examine the contents of the bottle in Exercise 1. The largest and the heaviest particles at the bottom are sand. The finest particles just above lying on the sand

and floating in the water are "silt" and clay. The little particles of leaves, twigs, etc., resting on the clay and floating on the surface of the water are called humus. Thus soil as a cold dead thing is made of sand, clay,

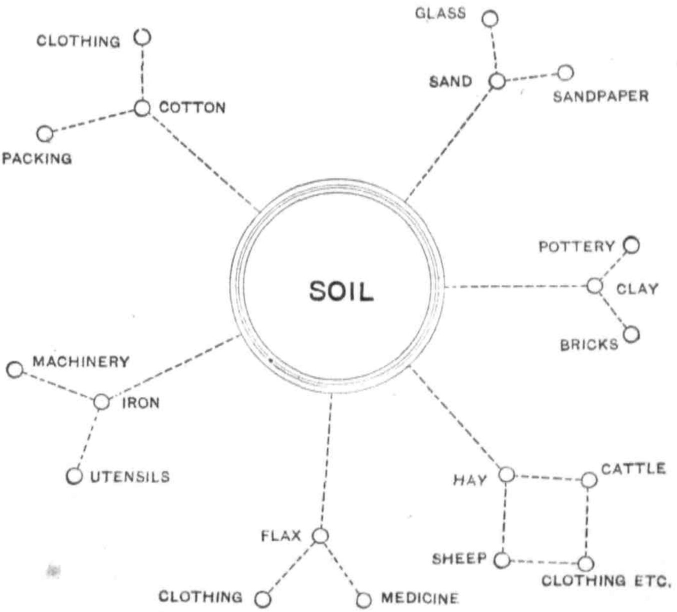

Fig. 2.

and humus (Exercise 1), but soil as we wish to know it, contains more; namely, water, air, little plants, and animals and their dead bodies.

Soil examination. Estimate the amount of sand,

humus, and clay in different samples of soil by using bottles and water (Exercise 1).

$\frac{4}{5}$ to $\frac{5}{5}$ or 80–100 % sand means sandy soil.
$\frac{3}{5}$ to $\frac{4}{5}$ or 60– 80 % sand means sandy loam.
$\frac{2}{5}$ to $\frac{3}{5}$ or 40– 60 % sand means loam.
$\frac{1}{5}$ to $\frac{2}{5}$ or 20– 40 % sand means clayey loam.
0 to $\frac{1}{5}$ or 0– 20 % sand means clay.

Characteristics of sand, clay, and humus. The sand particles are the larger, and they roll about more

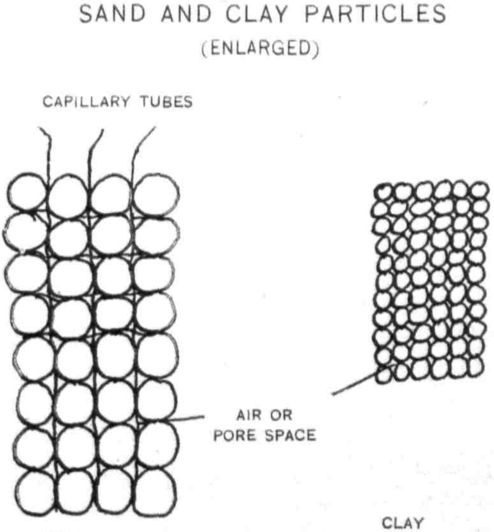

FIG. 3.

readily than do the clay particles (Exercise 2). The picture (Fig. 3) shows particles of sand and clay very much enlarged.

"Pore"[1] space means the space between particles of soil which may be filled with air or water. Exercise 5 showed that the pore space is less in the sand than in the clay, hence sand cannot hold as much water as clay.

Sand ordinarily contains little food for plants, but it makes soil loose and open so that air and moisture may be obtained by plants growing in heavy, clayey beds. Sandy soils plow easily. Sand is warmer than clay, as you learned through Exercise 4; hence it tends to make soil warm.

Clay is made of very fine particles. When it is moist it helps to bind sand. Clay is a storehouse for plant food, as you will find later.

Humus, which is decayed and decaying vegetable and animal matter, resembles clay more nearly than sand in size of particles, warmth, etc. Trees, flowers, and other plants add humus to the soil. Humus is very necessary. It holds sandy soils together and loosens soil containing a great deal of clay. Humus is also a food storehouse for plants.

A brick chimney is made by piling one brick upon another. Nature piles sand particles and clay particles in such a way as to form "chimneys," or tubes, in the soil. The tubes made by the sand are larger than those built in the clay and the humus. The name for the

[1] To Teacher. When necessary, the words in quotation marks should be more fully explained.

soil chimney is capillary tube. The tubes run towards the surface, laterally, sideways, and in all directions.

QUESTIONS

1. What is soil?
2. Which is the heaviest, sand, clay, or humus?
3. Why are foothill farms usually sandy?
4. Why are there so much clay and humus in valley soil?
5. Of what use are clay, sand, and humus in soils?
6. What are capillary tubes?
7. Are the capillary tubes smaller or larger in sand than in clay?

NOTE. Read Exercises 1 to 7 of Chapter II. Perform Exercise 5 at home. Set up Exercise 6 and get the material ready for the other experiments. Also set up Exercises 4 and 6 of Chapter III, Experiment 5, Chapter IV, and Exercises 1, 2, 3, 4, of Chapter IV.

CHAPTER II

WATER AND SOIL

Exercises

1. Arrange chimneys and tumblers, or tubes and bottles, as shown in Figs. 4*a* and *b*. Pour the same amount of water into each at the same time. Note through what kind of soil the water passes most rapidly.

GRAVITATIONAL WATER

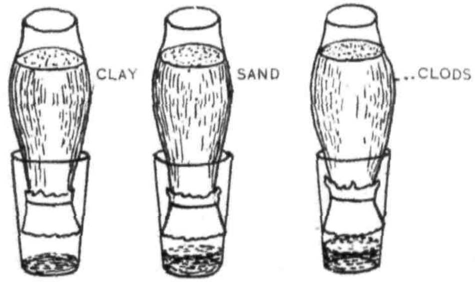

Fig. 4*a*.

2. Arrange as in Fig. 5. Put colored water into the tin. Note the action of the water and the color of the soils. The soil in each chimney should be dry before the chimney is placed in the water.

3. Ask your teacher to make you several fine glass capillary tubes of different sizes. Stand these in colored water, as shown in Fig. 6. Observe the action of the water.

4. Wash a pint of sand; heat until dry. Fill a tube and pour colored salty water on the sand. Note the taste and color of the water as it is collected below. How do you account for the change in color and taste?

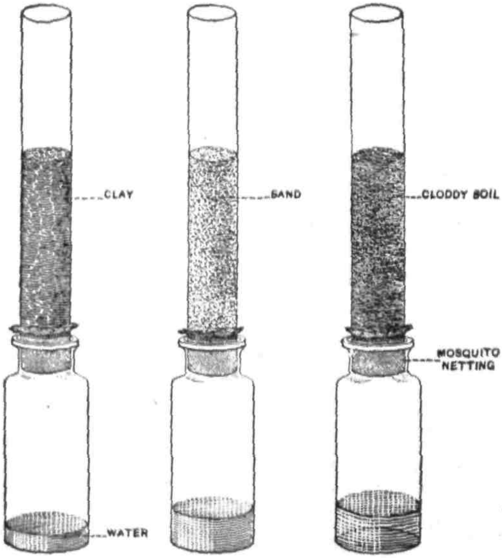

FIG. 4b.

5. Hold a cold saucer over the spout of the teakettle. Observe the drops of water as they form and fall. This is an artificial rainfall.

6. Arrange tubes of dry soil as in Fig. 4*b*. Substitute "leaf mold" for cloddy soil. Add water to each until it begins to drip through. Let the tubes stand and note the amount of water which collects in the bottles.

CAPILLARY WATER

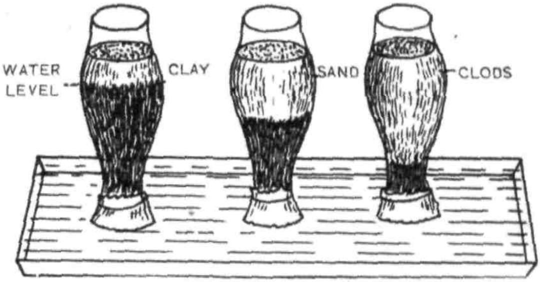

Fig. 5.

7. Moisten samples of clay, sand, and garden soil (containing much humus), roll into balls, and set aside to dry. Mix samples of clay and sand, humus and clay, humus and sand. Moisten and place to one side. Make a ball of slaked lime and clay. Also spread out and set to one side samples of the same mixtures. Note the general appearance of the samples before and after moistening, also several hours later.

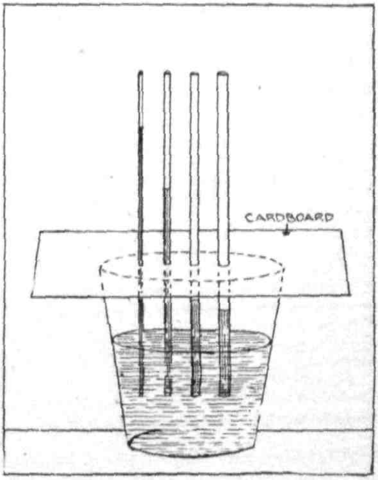

Fig. 6.

The work of water. You have learned that soil is more than "dirt" which gets in the way,

and so water is more than something to drink. Let us see what the work of water is. In the ocean it beats upon the shore, breaking the rocks to form soil. The ocean swarms with animals which furnish us with food. Drop a little water on the hot stove and see how active the water becomes. Sometimes the water seeps through the ocean bed, strikes hot rocks, forms steam, and bursts the side of a mountain.

Water "evaporates" from the ocean, strikes a cold body of air, becomes fog or a cloud, and is carried over the land, and falls as rain. Everything awakens with the warm spring rains. The farmer puts in seeds. The seeds send up the young plants, and the country turns green and becomes alive with flowers. Water not only awakens the young plants, but it carries food to them (Exercises 2 and 4. The color and salt in the water were held in the soil.[1]) The wells are filled. The rivers rush towards the ocean, bringing soil from the mountains to the valleys below. If you dip up a little rain water and set it aside for a short time, the water will evaporate, leaving soil which it has carried for miles from the mountain. (See Chapter XXXI, "Origin of Soil.")

Thus water helps to make soil, and carries it to the valleys where the great majority of people live; it scatters and awakens seeds; it waters animals and plants, and carries food for all. Without it there would be no life.

[1] Rain water contains little plant food. The plant food referred to is in the soil and is carried about by the soil water.

Gravitational water. A ball thrown into the air falls. The force of "gravitation" pulls it and all bodies towards the earth. The rain falls and sinks through the soil until it may reach a hard layer, which it cannot penetrate, or much of it may pass off as underground water. This is called gravitational, or free water. Gravitational water as it sinks carries some food to plants and helps to awaken life in the soil

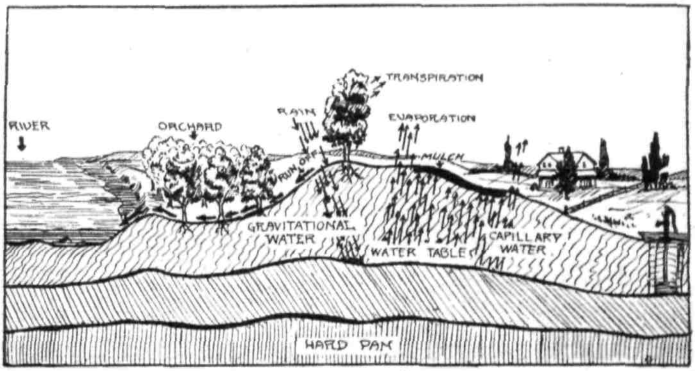

FIG. 7.

(Fig. 7). In the spring it warms the soil, while in the fall it cools. If the soil has not been plowed, this water may not enter, particularly if the soil is clayey in nature. It may run off to the creeks and be lost in the ocean; or it may run down a hillside and may cause a flood. (See Fig. 7.) What can be done to conserve, or save, the "run-off" water? Plowing opens the surface

and holds the water until it soaks in. On a hillside one should plow around, not up and down. Plowing around a hill is called contour plowing. Each plant has a mass of roots which is like a big sponge. Growing trees on the hillsides and protecting our forests will prevent the loss of run-off and make use of gravitational water. (See Chapter XXX on "Trees.")

Exercise 1 taught that gravitational water runs rapidly through sand. Land with a sandy base less than 5 feet from the surface cannot be watered sufficiently unless there is plenty of water for "irrigation," for the water would run through it and be lost. By using a post digger one may test land before buying.

Capillary water. During the rainy weather the ground gradually, like a great sponge, fills with water. After the rains stop, the water in the soil climbs to the top slowly and is lost unless evaporation is prevented (Fig. 7). This is "capillary water." Capillary action is greatest in clay. In Exercise 2, the water rises most rapidly in the sand at first. The water in the sand is a "short distance" runner, while in the clay it is a "long distance" one; that is, the water may rise more rapidly in the sand at first, but in time the water will rise higher in the clay. Not only does soil water rise upward more rapidly in

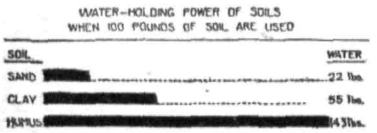

FIG. 8. — How humus aids in holding moisture.

clay, and to a greater distance, but it also spreads to a greater distance on all sides.

Clods and water. Capillary action in the tube of cloddy soil (Exercise 2) was very slow. It is the capillary water which brings nourishment to the plants during the dry weather. The seed bed should be very fine and contain much clay and humus. A cloddy bed would dry out quickly, and water would not climb to the seeds.

FIG. 9. — Mulching the soil.

The soil mulch. If, in Exercise 3, you should break the small tube below the surface of the water in the tube, what might happen if the water did not stick to the edges of the tube? How might the loss be stopped? Soil water is continually escaping from the capillary tubes. They may be broken and partially filled below by stirring the soil with a hoe or rake. This careful breaking up of the soil surface forms a "mulch" which prevents the water in the soil from

escaping (Fig. 7). Enough rain falls each year in most countries to grow plants without watering, if the water is kept from escaping. Your motto in the garden should be, Work the watering can less and the hoe more.

Dry farming. The plowing of soil to catch the rain, and the mulching to prevent the escape of the soil water, are the main steps in dry farming.

Questions

1. What causes a volcano?
2. Name the uses for water.
3. What is gravitational water? Of what value is it?
4. How may gravitational water be saved?
5. Why is it a poor plan to buy land with a sandy base unless there is plenty of water for irrigation?
6. What is capillary water? In what kind of soil does it work best? Why?
7. What causes the water to climb up the lamp wick.
8. Of what harm are clods in a seed bed?
9. What is meant by a mulch?
10. What is dry farming?
11. What is a good motto to follow in gardening?

Home Studies

1. What farms in your locality are well taken care of; that is, well plowed and cultivated? What effect has deep plowing in saving soil water?
2. How does the farmer get rid of clods?
3. Why do some farmers plow with horses while others plow with traction engines? What does a traction engine

cost? What is the cost of a plow? A horse? What evil may result from plowing to the same depth year after year?

4. Which is the better place to begin plowing, at the center of the field or at the edge?

5. Why does an orchardist roll his orchard?

6. At what times during a year do the farmers plow in your locality?

7. What does it cost to plow and to cultivate an acre of ground?

8. Make a list of tools used on a farm for plowing and cultivating.

9. How does the farmer make a dirt mulch?

10. How often is the land allowed to rest that is not plowed? Is any use made of this land for pasturing, etc.?

CHAPTER III

THE SEED AND ITS NEEDS

Exercises

1. Arrange two plates, blotters, and seeds as shown in the picture. Moisten the blotters as needed. Use beans, radish, and other seeds. Examine the seeds daily. (4 da.)[1]

2. Fill an open-mouthed bottle or tumbler half full of warm boiled water. Drop in a few seeds (Windsor beans, or squash seeds if preferred). Note the bubbles. Where are they coming from? How does water first enter the seed?

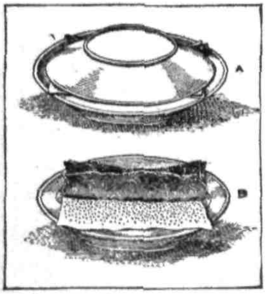

Fig. 10.

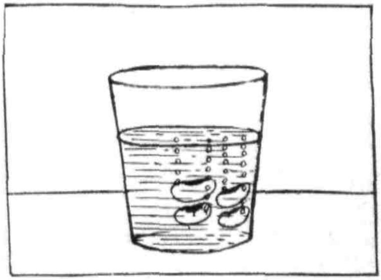

Fig. 11.

3. Examine a bean pod. Open it carefully. Pull off a bean and notice where it fastens to the pod. This is the hilum (Fig. 14).

[1] To Teacher. To be ready for the demonstration lesson this experiment should be set up four days ahead. Note the time limit as indicated by words within the parentheses.

4. Arrange material as pictured. Chalk boxes may be used. Bury six Windsor, or lima, beans, or six kernels of corn, half in the soil with scarred end, or hilum, down. Bury six beans with scarred end up. Note results from day to day. (1 wk.)

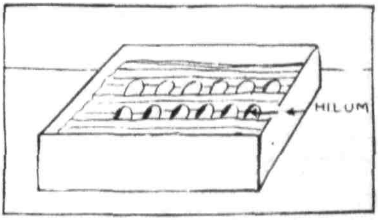

Fig. 12.

5. Float two halves of a walnut or peanut shell on water. Place sugar carefully in one. Observe from day to day. Treat the coats of squash seeds in the same way. Note results.

6. Between two plates of glass place two or three thicknesses of blotter. Next to the glass on one side place wheat; on the other, place corn. Place the apparatus in water. Note the growth of the roots. (2 wk.)

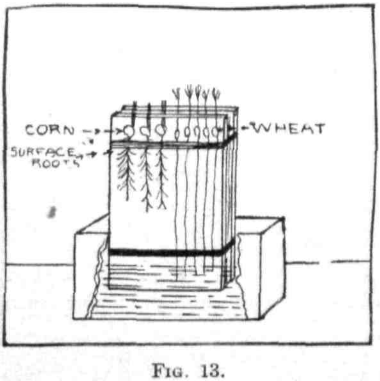

Fig. 13.

If you were to plant peas to-day in your garden, weather permitting, would you know just what to do? Few people know much about seeds. This chapter and a few others which follow will tell you how to plant your seeds.

Water awakens the seed. A dry seed may lie asleep, or dormant, for years. Add a little water, and soon it

rids itself of its coat and the young plant begins to grow. Exercises 2 and 3 told you that the water enters first at the "micropyle," a little opening near the hilum. Just as soon as the water enters the seed, activity begins. Sugar is made from the starch in the seed, and water passes through the seed coat, just as it passed through the walnut shells and the coverings of the squash seeds, into the seed. Thus seeds must be planted deeply enough in the soil to cover the hilum and the micropyle.

The seed. Select a bean which has germinated, or started, and open it carefully. Find the embryo, or little plant. It has a short stem and the beginning of a root. The little stem has a bud or small leaves on it. This is the plumule, and it grows into the main stem and the leaves of the new bean plant. The embryo needs food at once. Find its food. It is stored in the seed leaves, or cotyledons. You have learned that a seed is a sleeping plant in a secure house, the seed coat, with enough food to last until roots are formed and the stem and leaves get above the ground. Therefore,

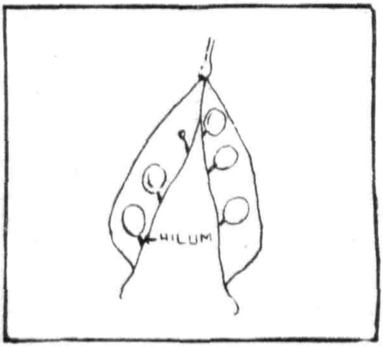

FIG. 14.

large seeds, such as beans, containing much food are planted more deeply than small seeds, such as radish. The general rule is to plant seeds from three to five times their long diameter.

FIG. 15. — A simple forcing frame for growing lettuce.

Mono-, di-, poly-cotyledonous plants. How many cotyledons has a bean? How many cotyledons has corn? All plants such as corn are "monocotyledons," plants with one cotyledon. All plants such as beans, "dicotyledons," have two. Some seeds such as pine tree seeds have many cotyledons and are called "polycotyledons."

Distance apart for plants. Examine the wheat and the corn roots (Exercise 6). The roots of the wheat run side by side and are very long. They are deep-growing roots. Plants having such roots may grow close to each other without crowding. The corn roots are not so long, and near the stem many surface and bracing roots are forming. Plants with branching surface roots must be planted far apart.

Many seeds do not germinate. At first sowing put many seeds in the trench, and later thin out the weak plants. Plants, as lettuce, which mature above ground, should be thinned until they are as far apart as the distance across a mature plant. Chapter X will tell you more about thinning your plants.

If you are not to have a school garden, ask your parents for a plot at home. The following chapters will tell you many interesting things about gardening.

Questions

1. Under what conditions does germination start in a seed?
2. Of what use is the micropyle?
3. What causes the water to pass through the seed coat?
4. From what is the sugar made in the seed?
5. Why should seeds be buried in the soil?
6. What is a seed?
7. How may we know how deep to plant seeds? What principle determines the rule for planting?
8. How are plants grouped?
9. How may we know how far apart to grow plants?

Home Studies

1. Examine the seeds of many different plants. What enables the seed to bury itself?
2. Dig up corn and wheat plants, wash off the dirt, and compare the roots.
3. Open several pea and bean pods. Are the seeds in the separate pods all the same size? Why?
4. Germinate as many seeds as you can find from weeds to the coconut. Note the embryo and food supply in each.
5. Note the great number of seeds produced by one plant. Why is this?
6. If you live on or near a farm, examine a handful of seed that is to be sown. Can you find any foreign seeds?
7. Make a list of seeds that are blown about, that are carried by water, that are distributed by animals.
8. Visit a nursery and see where flower seeds come from.
9. Visit a seed house and learn the methods that are used to grow and to handle the seeds.[1]

[1] Obtain help, if necessary, from your teacher or your parents in doing the work connected with the Home Studies.

CHAPTER IV

THE SEED AND ITS NEEDS *(continued)*

Exercises

1. Place peas or beans in two bottles, and arrange as shown in Fig. 16. Use moist cotton or sawdust in the bottom of the bottles. Observe from day to day. (1 wk.)

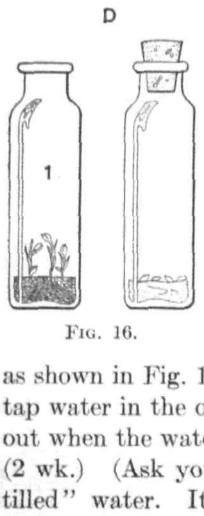

Fig. 16.

2. Plant wheat in two tumblers or cans (Fig. 17). Moisten the soil in one. Keep water standing in the other. Observe each day. (1 wk.)

3. Put beans in three open bottles containing a little moist cotton. Place one near the stove, one outside but protected from rain, and one on the window sill away from the stove. Note results each day. (10 da.)

4. Arrange two tumblers, suspending seeds in the water with mosquito netting, as shown in Fig. 18. Put distilled water in one and well or tap water in the other. Be sure that the seeds do not dry out when the water evaporates. Add water as it is needed. (2 wk.) (Ask your teacher to tell you how to make "distilled" water. It contains no plant food.) Note results. Explain.

5. In a box of moistened sawdust or soil place three rows of lima beans. (These may be obtained from any seed company.) As the seed leaves, or cotyledons, appear, break

them off the plants in the first row. A week later treat the second row in the same way. Let the seed leaves remain on the third row. Observe what happens. (3 wk.)

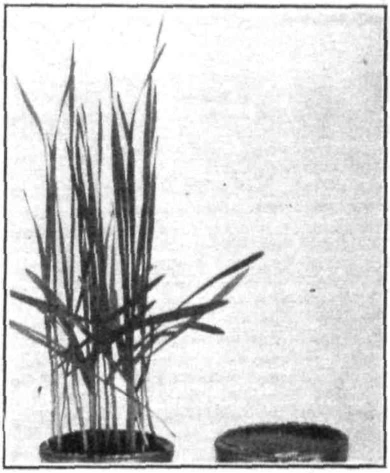

Fig. 17.

6. Make two or three openings in a chalk box. Fill the box one half full of wet sawdust, plant several seeds, and cover the box. Note results. Keep the sawdust moist. (2 wk.)

7. Start one plant in a dark and another in a light place. Observe every two or three days. (2 wk.)

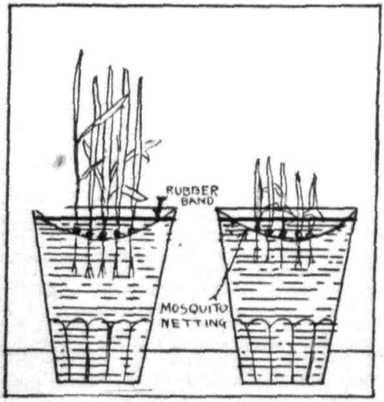

Fig. 18.

Plants need air. Exercises 1 and 2 show very plainly that plants need air. What can be done in order that seeds shall have plenty of air in the soil?

You have learned that humus opens clay. Thus air would enter the seed bed more readily if humus were

added. Humus prevents soil from baking, again keeping it free for the entrance of air.

Plowing, spading, and cultivating make the soil open and porous. The finer the particles, the more air space. Besides, the water supply is increased, and soil food more readily reaches the fine root hairs in the fine soil.

Seeds should not be planted when the ground is too wet, for most of the soil air has been driven out (Exercise 2).

Plants need warmth. Exercise 3 teaches that plants need warmth, but not too much. The warmth of soil may be modified by altering its general make-up. Sand is warm. Clay is cold. By mixing sand with clay the soil is given warmth. Of course it is not practicable for the farmer to add sand to a large field.

Avoid planting seeds during the cold, wet season and during the hot weather.

Fresh manure, which heats soil, should not be added during the hot weather. Well-rotted manure may be used as a mulch to prevent the loss of moisture.

Plants need food. Exercise 4 teaches you that plants need food. However, as you noticed, the plants did very well in both tumblers for several days before those in the distilled water began to fail. This is easily explained. You have learned that a seed usually contains a young plant and enough food to keep it growing until roots and leaves are formed. From that time the plant must get its food through the leaves and roots.

Distilled water contains no plant food, hence the roots could not carry food to the plants, and they died. Exercise 5 shows that the seed leaves, the storage house for the embryo plant, furnish food until the young plant gets established. The plants in the third row have done the best of all. The plants in the first row from which the seed leaves were picked are doing very poorly.

The embryo plant does not need light. The natural place for seeds is beneath the surface of the soil. Therefore the embryo plant does not need light.

The plant above ground needs light. Light is essential to the plant after the seed food has been used. Notice how the plants in the room lean toward the window. Later you will learn how plants make sure of plenty of light.

The sun rises in the east and sets in the west. Rows of plants should be planted north and south so that sunlight may strike the plants from all sides and the soil between the rows. Sunlight helps to keep soil " mellow " and " sweet."

An ideal garden should slope gently toward the south in order that the sun's rays may fall more directly on the plants and on the soil.

Many flowering plants need a great deal of sunlight. Others do well in the shade. Plants such as ferns do best in cool, shady spots.

NOTE. In talking about the needs of a seed we mean the needs of the living plant within the seed coat.

Questions

1. What does the embryo plant need for growth?
2. What may be done to the seed bed to furnish air to seeds?
3. Why should seeds not be planted while soil is wet?
4. How may a seed bed be made warm?
5. When should manure be added?
6. How do you know that plants need food?
7. What is the main use of the cotyledons?
8. How do you know that plants need light?

Home Studies

1. How does the farmer nearest you prepare the land for air, for warmth, for food, for sunshine?
2. Why are the plants in your vicinity that grow close together so tall?
3. Notice the limbs of a tree; why are some dying? Why are there no branches on the lower part of a tree?
4. How far apart should different kinds of orchard trees be planted to insure enough sunlight?
5. How does irrigation furnish food to plants?
6. What is meant by "cover crops"? Of what value are they to the farmer? What plants are called legumes?
7. Find out a way to irrigate with manured water.
8. What is the cost in labor, etc., of manuring an acre of land? Of adding lime to an acre? How is lime put on the soil?

Note. Get the material ready for the exercises given in Chapter VI.

CHAPTER V

SOME CHARACTERISTICS OF AN IDEAL SEED BED

Examine the samples of earth prepared in Chapter II. Which has the greatest power of holding its particles together? Which would be the most likely to bake? What effect did the humus and clay have on the sand? What effect did the sand have on the humus and clay? What effect did the lime have on the clay?

Sand. Our experiments have shown that sand is heavy in weight, but light to plow; that the particles are large; it is warm in temperature; that water runs through it rapidly and does not climb back very far, and that it loosens clay; that the pore space is small, hence the sand does not hold much water as compared to clay and humus, and that it does not retain water well. (See Fig. 8.)

Clay. It has been shown that clay is heavy to plow; that the particles are small; that it is cold; that water runs through it slowly and climbs back many feet; that it holds much water and retains it well; that it contains plant food; that it binds sand together; and that it packs and puddles when wet.

Humus. It has been shown that humus binds sand particles and loosens clay particles; that it contains plant food; that it holds water very well.

Lime. Lime, which loosens clay, may be added to soil with a drilling or spreading machine. For large acreages it is more practicable to add lime than sand to open and to sweeten clayey soils.

An ideal soil. Knowing these things about sand, clay, and humus, let us see what some characteristics of an ideal soil should be and how they may be brought about.

Soil a reservoir for water. Clay and humus hold water best. Most of the soil water comes from rain which does not fall regularly, so an ideal soil must receive and hold water to supply the plants during dry weather. It is not practicable to add clay to the sandy soil of a large piece of land. Humus may be added by stirring in well-rotted manure. Sometimes clovers, cowpeas, and similar plants are grown and plowed under.

Soil must be warm. Soil which is too clayey in nature not only packs, but is often too cold for plant growth. Such a soil is loosened and made warm by adding sand or lime.

Soil must be porous. Clayey soils are loosened by adding humus, lime, and sand. A sandy soil is too open and dries out too quickly. Humus absorbs and holds moisture, and thus would improve it.

Soil must contain plant food. An ordinary sandy soil contains little food, as you will learn later. Humus added to such a soil improves it.

A good soil. A good soil should contain enough clay and humus to hold water and to lead it towards the surface. It should contain enough humus and clay to furnish food for plants. There should be enough sand to make the soil porous and warm, and finally, as you will learn, such a soil must contain minute plants — bacteria.

Good soil necessary for plant growth. Before starting your garden at school or at home, examine the soil to see if it needs treatment. If plants are growing well in the soil near the purposed garden spot, probably the soil will not need especial care.

Questions

1. What change is made in a clayey soil when sand is added?
2. How would you improve a sandy soil?
3. Why are air and water needed in soil?
4. How might humus be added to soil?
5. Name some of the characteristics of an ideal soil.

Home Studies

1. What is the average rainfall of your district? Is irrigation necessary?
2. Observe young plants in the morning. Where does the moisture come from? What is dew?
3. What effect have weeds on soil moisture?
4. Find out how much water is lost by an acre of corn or wheat.

5. Make a collection of a few soils found in the neighborhood. Make a physical analysis of each. See Chapter I, Exercise 1. Note the plants growing in each different kind of soil. Make a list of plants best suited to sandy soil; to clayey soil.

6. Notice the difference in color between hillside and valley land. Why is this?

7. What has been done by the farmers in your vicinity in attempting to improve the soil?

8. How does the farmer work adobe, or clayey soil?

9. Name a method used by the farmer to loosen clayey soil without adding sand.

FREE BULLETIN

Management of Soils to Conserve Moisture — Farmers' Bulletin No. 266.

REVIEW QUESTIONS ON CHAPTERS I–V INCLUSIVE

1. Of what is soil usually composed?
2. What is meant by dry farming?
3. What may be gained by letting land rest?
4. Name some of the points which help to make an ideal soil.
5. How may sandy and clayey soils be benefited?
6. What is a seed?
7. How should a seed bed be treated to furnish air, water, and food to the seed?
8. How do you know the depth to plant a seed?
9. Why are there no limbs on the lower part of a pine tree and no leaves on the branches near the trunk?
10. What are "cover" crops?

CHAPTER VI

PROBLEM QUESTIONS

SOON you will be at work in the gardens. To grow vegetables which will be just as good as those the vegetable man sells and to grow flowers such as you can buy at the "florists," you should be able to answer the following questions:—

1. Will seeds grow well in sand? In clay? Or better in a mixture of the two?
2. Will seeds grow well in a cloddy seed bed?
3. Will you wet the seed bed just before spading and raking?
4. What causes the roots to grow downward?
5. Will you irrigate with "trenches," "flood," "sub-irrigate," or sprinkle your garden?
6. If sprinkling is necessary at first to start the seeds, when should it be done?
7. Does "cultivation" keep the soil water from escaping?
8. How deep will you plant your seeds? Is the rule "Three to five times the long diameter" a good one?
9. Does a "puddled" or baked surface tend to prevent plant growth?
10. Which holds water the better, clay or sand?
11. Is there any gain in soaking such seeds as beans, radish, onions, etc.?

There are two ways to answer these questions. You can ask some one to answer them for you, or you can set up the

experiments and answer them yourself. You will take the second method if you really want to learn.

EXERCISES

1. Get three chalk boxes. Fill one with clean sand, one with clay, and one with a mixture of sand and clay. Moisten the soil in each, and 24 hours later sow ten of the same kind of seeds in each box. Note results.

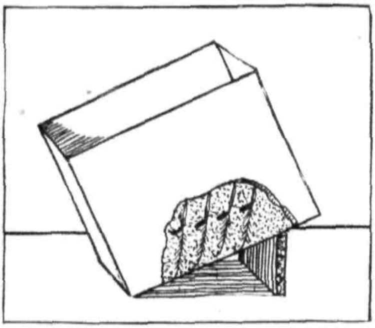

FIG. 19.

2. Get two chalk boxes more. In one place fine soil. In the other put cloddy soil. Water alike and sow ten seeds the same depth in each. Observe daily.

3. Fill a box with dry soil. Add water and stir at once. What happens? Fill another box with dry soil. Water and set the box aside. Stir the soil next day. Which is the better way?

4. Knock out the bottom of a chalk box. Tack wire fly screen in its place. Fill the box one third full of sand or sawdust. Arrange the box as shown in Fig. 19. Plant wheat seeds in the sand or sawdust. Add water. Watch

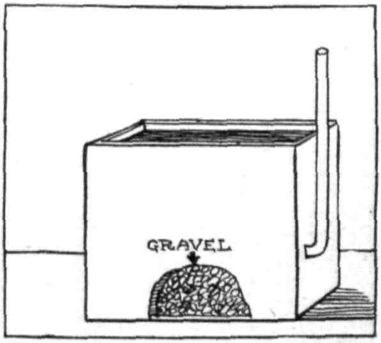

FIG. 20.

the roots. Why do they grow through the screen first and then turn back?

5. Get four boxes about 12 × 14 inches in size. Prepare enough moist soil for all. Plant the same kind of seeds the same depth in rows in each box. The rows should be about 4 inches apart. Sprinkle a pint of water on one box of soil. Dig trenches between the rows in the other box, and pour a pint of water into the trenches. Cover the trenches after the water soaks in. Add the same amount of water as needed to both boxes until one quart has been added. Pull up a few plants from each box and compare the root growth. The sprinkled plants will probably have roots near the surface, while the others will have long roots, Fig. 21. Flood one box with a quart of water. Give it the same treatment as the others, but do not add any more water. Make a hole in one side of the other box. Insert a funnel snugly (Fig. 20). Pour into the soil, water as needed until one quart has been used. This shows the method of subirrigation. Which is the best way to water the soil for plant growth? How does a farmer subirrigate his land? Observe all carefully — and Question 5 will probably be answered correctly.

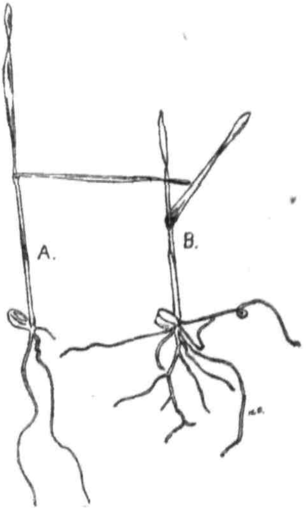

FIG. 21.

A = A plant irrigated by trenches — deep set roots.
B = A plant irrigated by sprinkling — surface roots.

NOTE. A tin can punctured several times about one inch from the bottom may be sunk into the soil to take the place of the funnel. Use this method to subirrigate young trees, potatoes — one can to a hill, etc.

6. Fill two boxes with soil. Plant seeds the same depth. Sprinkle both. Put one in the sunshine each day after watering. Put the other in the shade. Note results.

FIG. 22. — A newly spaded lawn. The surface roots of the cherry trees were caused by sprinkling the old lawn.

7. Prepare two tomato cans of soil that weigh the same. Add the same amount of water to each. Each day, some time after watering, stir the surface of the soil in one can with a small stick. Weigh every other day. Which loses water the more rapidly? See also Experiment 10.

8. Line a tumbler, or fruit jar, with black cloth and fill with sand or sawdust. Place seeds at different depths between the cloth and the glass. Moisten the contents of the tumbler. Note results daily. Which is the best depth

for the seeds? How many times the diameter of the seed is the best depth?

9. Plant onion seed and corn in a tumbler filled with clay soil. Pour a little water on the top. Puddle the surface by rubbing it smooth with your finger. Observe the plants day by day as they struggle to lift the caked surface.

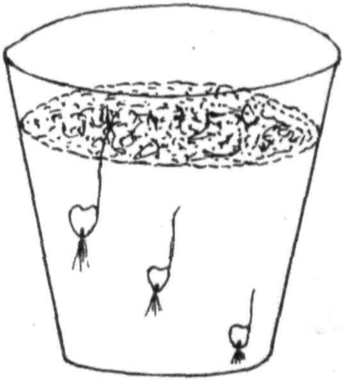

FIG. 23.

10. Arrange apparatus as shown in Fig. 24. Use an umbrella rib for the lever. Bring the lever to balance at the beginning of the experiment. Note what happens each day.

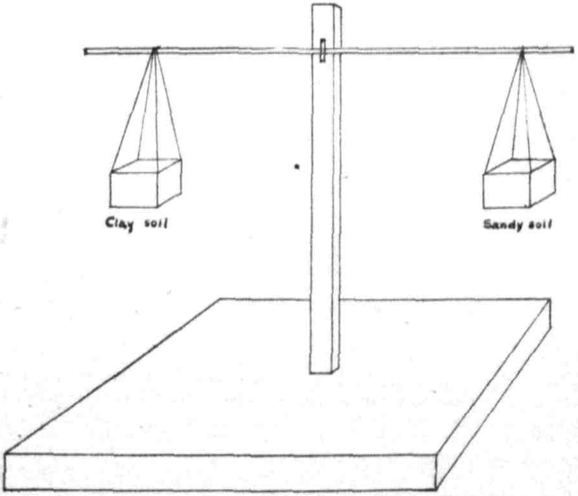

FIG. 24.

11. Soak six beans 24 hours. Plant them with six beans not soaked the same depth, about six inches apart. Note results.

It will take some time for each pupil to set up these exercises at school. Would it not be well to divide them among the class? You could arrange at least two experiments. Your neighbor two, and so on, and then all could tell results. You could each perform all the exercises at home.

You must not get discouraged if your experiments go wrong. "Try, try again."

CHAPTER VII

THE GARDEN

Now you are ready to start your garden. You should have a home garden whether a garden is given to you at school or not. You may start your garden at any time where the weather is not too severe. If started in the fall in some states, you must first water the soil well several days before spading. (Exercise 3, Chapter VI, showed this). Plant vegetables and

FIG. 25. — A home garden.

NOTE. In order to secure good results in the home garden it may be necessary to have a small demonstration plot in the corner of the school yard or elsewhere in which the teacher may show the new steps to be taken and the methods to be followed in the home garden. Here one may demonstrate to the class how to spade, rake, mark the rows, plant seeds, etc.

flowers so that your garden will produce crops throughout the year, weather permitting.

Selection of plot. Select as good soil as can be found in a sunny place. If the soil is too clayey, add sand. If humus is necessary, stir in deeply two inches of dry, decayed manure. Plants do not grow well in sand, or clay alone, as shown by Exercise 1, Chapter VI.

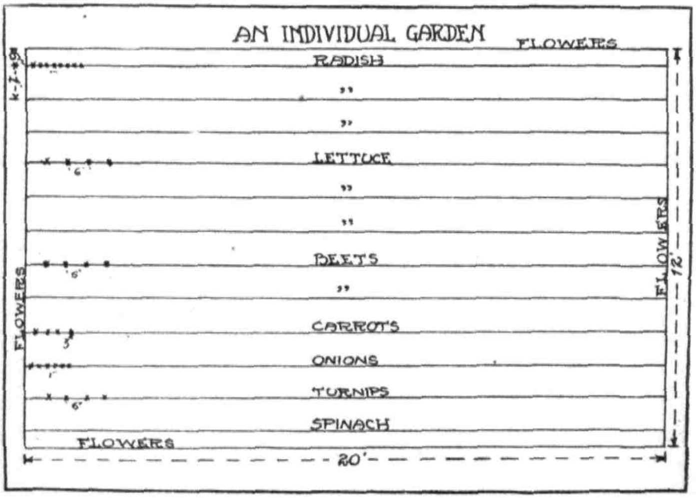

FIG. 26.

Laying out the garden. Do not make your first garden too large. A plot 10 × 20 feet for vegetables and a smaller space for flowers will be about all that you can attend to. Note the simple plan for the vegetable and flower garden (Fig. 26).

Most vegetables are sown in rows. The rows should be far enough apart to allow ease of cultivation and trench irrigation; that is, 10 to 14 inches. Such plants as corn, potatoes, tomatoes, etc., should not be grown next to rows of radish and other low-growing plants. Grow them in plots by themselves. Tall-growing

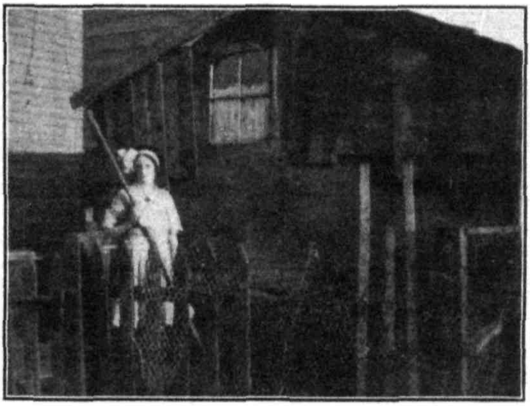

FIG. 27. — Before planting.

plants are best grown on the north so as not to shade others.

A large garden. You may wish to grow vegetables either at home or at school to sell in the market. Here is what some children have done. "During the first year I raised enough garden truck to supply our own family, and besides that I sold twelve dollars' worth to the neighbors. With this I bought myself a watch and chain," said one gardener from Ohio. Another raised

one hundred five dollars' worth of vegetables and sold about half of them. One girl sold enough vegetables in one year to supply the family and to buy a bicycle.

Figure 29 shows a method of irrigation used by truck gardeners. It insures plenty of water to the plants, at

Fig. 28. — After planting.

little expense for labor. Of course the surface of each plot must be level.

If a garden is started before the rains, raise a small levee, or embankment, around the whole plot and flood with three or four inches of water. The ground should be plowed or spaded, raked or "harrowed," and made with a slight slope. If the plan pictured in Fig. 29 is used, the main trench should be made by banking up loose soil. Each plot should be banked in the same

way. Sow seeds "broadcast" or in rows. Thin out and cultivate as needed. From a hose, a hydrant, or a stream run the water into the trench *D* (Fig. 30). Remove a portion of the bank at *B* and dam the trench with the soil. Flood *A* with two or three inches of water. Treat the other plots in the same way. After

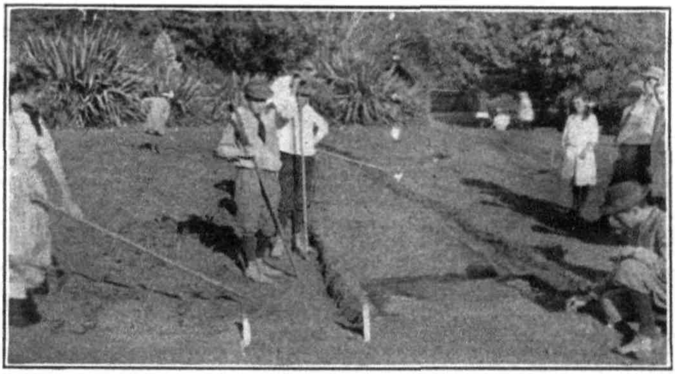

FIG. 29. — Flooding the plots.

a few hours, cultivate each plot. In the hot weather such flooding may be done once a week, or less often.

Flowers and vegetables that are grown in hothouses often excel, because the temperature and the water supply may be controlled. The ideal condition for your garden and for a farm is one of "equable" temperature and little rain, but plenty of water for irrigation. Your garden and a farm will produce best if water is supplied properly. Through the check plan

of gardening you may learn how much water to apply. After the plants are up, flood one plot twice a week, another once a week, another twice a month, still another once a month. Add one inch of water to

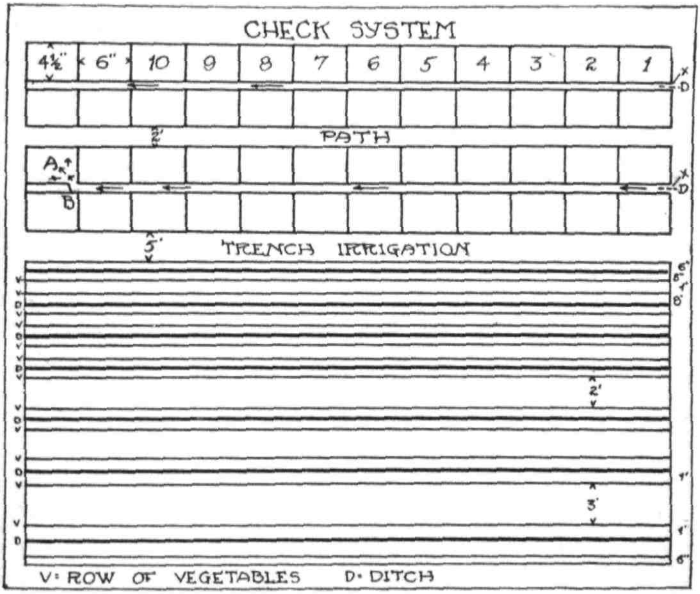

Fig. 30. — Plan of irrigation.

each. Treat another series of plots, adding three inches of water. See that each plot is treated alike as to planting, cultivation, thinning out, etc. Keep a record of the plants' growth and determine the amount of water and cultivation that the vegetables and flowers need.

See Chapter XXV for other experiments to perform, if this check system is used.

Figure 30 also shows another method of irrigating a large garden. Vegetables grown close to the trenches receive water in large quantities from below. Therefore the roots grow deep in the ground; and excellent plants are obtained. Room is left between the rows for thorough cultivation.

If you make a plan of the back yard for both vegetables and flowers, here are a few points in flower growing to think about. (See Appendix for the city home score card.)

(1) Flowers should not be scattered about, red here, yellow there. It is better to have a gay show of reds, yellows, blues, etc., as one color scheme throughout the garden. (See Appendix for calendars of vegetables and flowers.)

(2) Tall flowers should not be grown next to short flowers.

(3) If there is a fence around your yard, grow sweet peas and let them climb over it. Flowers show off best when seen against a background. Such a background may be a building, a rock, a fence, trees, shrubbery, an ash barrel, etc.

(4) Do not grow flowers in an open lawn. The lawn should be a solid unbroken green with possibly a tree or two.

(5) Flowers may be used to edge a path, to screen a rubbish pile.

(6) If there is a tall fence around your back yard, try this plan. Grow double sunflowers close to the fence. Follow with coreopsis and edge with dwarf yellow nasturtiums.

(7) Study the flower calendar in the back of the book for colors and heights of plants.

With your garden planned, get a string, stakes, a mallet, a yardstick or tape line, and stake out the garden. Paint the stakes one color and make them all the same size, about 14 inches long by $1\frac{1}{4}'' \times 1\frac{1}{4}''$. Stretch the string from post to post to guide you in keeping the stakes in line. Make the stakes in the manual training department or at home. Prepare three stakes for each pupil who has a school garden.

FIG. 31. — Use the hoe and the rake with a sweeping movement.

Tools. A spade (woman's spade) or spading fork, a hoe, a rake, and a few hand tools are needed. You may have to furnish your own tools. The school may furnish them. In either case, take care of them. Put them in the tool house or a box carefully and well cleaned. When not being used in the gardens, lay the hoes and the rakes with the prongs down. Some one may fall or step on them. Probably

there will not be enough tools to give each pupil a set. Remember your neighbor, and be satisfied with one tool at a time. A tool broken by a gardener should be fixed or replaced by him.

FIG. 32. — The natural position in spading.

Use of tools. There is a right way to use tools. When you are ready to spade, stand in one corner of your plot close to and facing one edge. Set the spade about six inches from the edge and press it into the ground to the full depth of the blade. If the ground is hard, work the handle forward and backward, then throw the dirt a few inches in front. Be sure to break up the clods thoroughly as each spadeful is turned over. Clods exposed to the sun harden quickly. Plants do not grow well in cloddy soil. (See Exercise 2, Chapter VI.) Continue spading

across the garden, leaving a trench in front. Guided by the trench, spade another row. Keep the trench open as each row is spaded (Fig. 33). With the whole plot spaded, or at least the part spaded which you wish

FIG. 33. — The "trench" method of spading.

to sow at once, rake back and forth to break up any lumps still left. It is a good plan to push the rake from you, after you have drawn it toward you, otherwise the soil will be drawn from the center to the edges. When finished, the bed should be soft, a little higher in the center than at the edges. It should be raised

about two inches. The edges should be in line with the stakes (Figs. 29 and 46). A string stretched around the plot will guide you in making straight edges.

The school garden. If you have a school garden your teacher will help you in planning and laying out the garden as a whole. (See Appendix.) An individual garden may be given you; you may work in a group with others; you may have an experimental garden, or you may be given the three privileges. However, what you have learned will help in the school garden.

Fig. 34. — Buy tools that will last and that are of a good size.

Unless your teacher has given you a plan to follow, work out some original way to mark off the plot.

A plot 40 by 100 feet does very nicely for a school garden. A less ambitious garden may be made in tin cans (Fig. 39), in pots (use soil consisting of $\frac{1}{3}$ sand),

or in boxes, where land is not available. Often a vacant lot may be made to serve. If such a plot is obtained, use it for the school garden, then have other vacant lots in the vicinity of the school plowed lightly or harrowed to a depth of four or five inches, and sow broad-

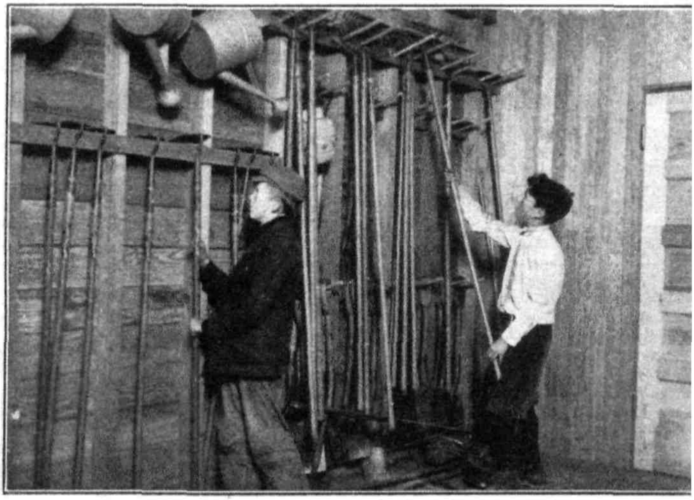

FIG. 35.— A well-planned tool house.

cast dwarf sweetpeas, nasturtiums, poppies, or other flowers. A vacant lot overrun with flowers is far more attractive than one flourishing with weeds. The sales from the school garden will more than pay for the additional plowing. A school garden should be self-supporting.

Follow all instructions closely so as to grow the *best* vegetables and flowers. Any one can grow a radish, but not every one can grow the best radish.

Plan with your neighbors to arrange your vegetables and flowers so as to make the garden as a whole attrac-

Fig. 36. — A school garden.

tive. A row of corn next to a row of beets would not look well. Two rows not parallel would not only spoil the appearance of one garden, but would make the whole plot less attractive. You and your neighbors must think of the good of all. With the seed bed carefully

spaded, raked, and formed you are ready to plant seeds. Do not be in a hurry to plant, however. The most important step in growing the *best* radish is a perfect seed

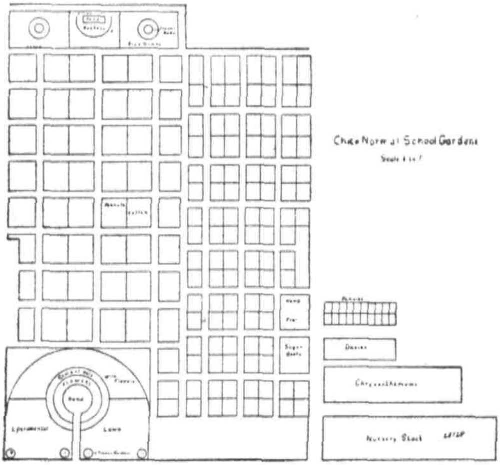

FIG. 37. — A school garden plan.

bed. After the seeds are in, little can be done to improve the bed. If clods persist, rake them into a pile. Dig a hole in one corner of the garden and bury them.

QUESTIONS

1. What should determine the choice of the garden plot?
2. How far apart should the rows be?
3. Why not plant corn and beets close together?
4. Give some rules for the growing of flowers.
5. Study the flower calendar in the back of the book, and arrange two color schemes for a garden.

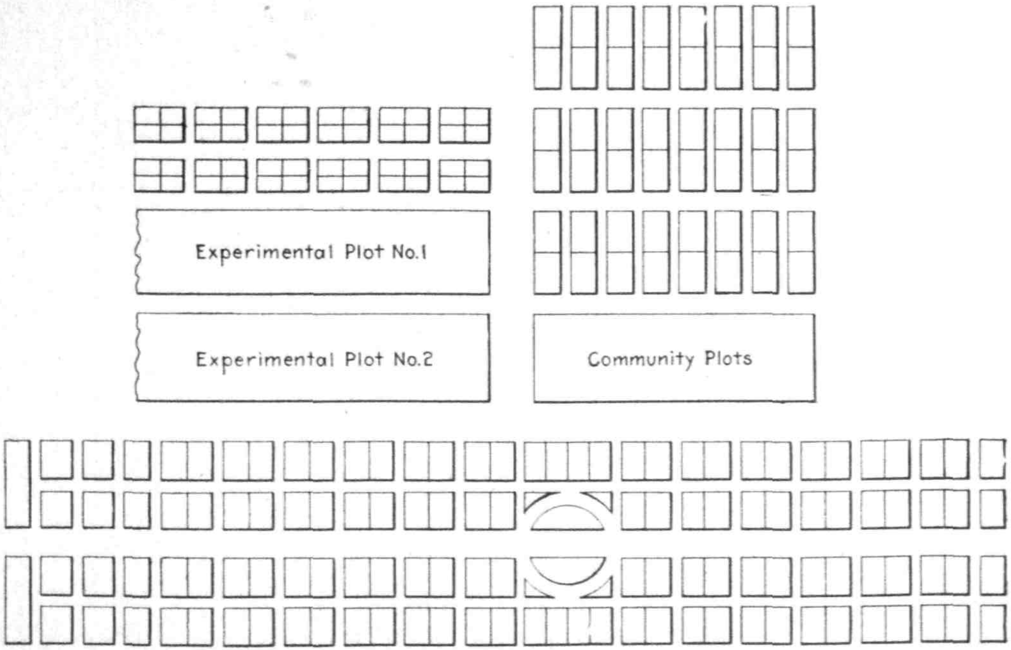

FIG. 38. — A school garden plan.

6. Explain the proper way to spade and to rake.

7. Describe an ideal seed bed.

8. What steps does a farmer take in preparing a good seed bed?

9. What should each pupil bear in mind to make the whole plot attractive?

FIG. 39. — A tin can school garden.

10. What is the most important step in growing the best vegetable or flower?

HOME STUDIES

1. Why does a farmer usually select well-drained land when buying?

2. Why will ordinary crops not grow on wet lowlands?

3. How might swampy land be reclaimed?

4. How far apart does the farmer plant corn and wheat? How are the seeds sown?

5. How might your own and the homes of others living near be made more beautiful? Make a rough plan of a flower scheme for your home.

Fig. 40. — A vacant lot before planting.

6. What will be the cost of such a garden as shown in Fig. 26? Find out what vegetables and flowers are worth, and estimate the profit to be gained.

7. What methods are used to irrigate orchards, gardens, and fields in your vicinity?

8. Of what value is arithmetic to you?

FREE BULLETINS

Irrigation in Field and Garden — Farmers' Bulletin No. 138.

Home Fruit Garden: Preparation and Care — Farmers' Bulletin No. 154.

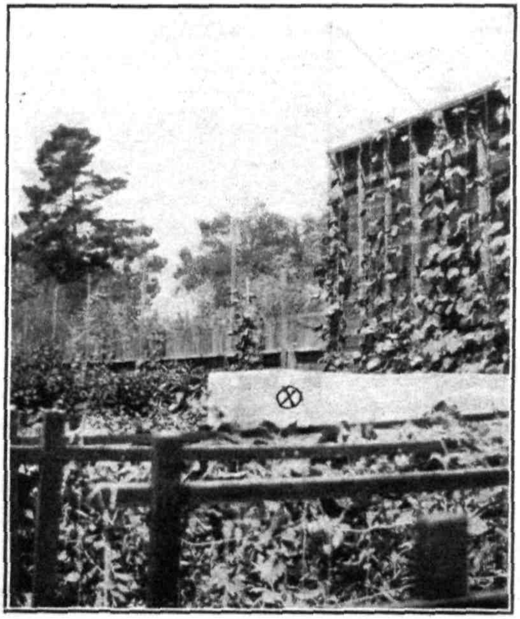

FIG. 41. — The same lot after planting. ⊗ a cheesecloth frame.

Drainage of Farm Lands — Farmers' Bulletin No. 187.

The School Garden — Farmers' Bulletin No. 218.

Information for Beginners in Irrigation — Farmers' Bulletin No. 263.

Soil Fertility — Farmers' Bulletin No. 257.

CHAPTER VIII

SEEDS

The best radish. The first step in growing a *best* radish is a perfect seed bed. The second step is *per-*

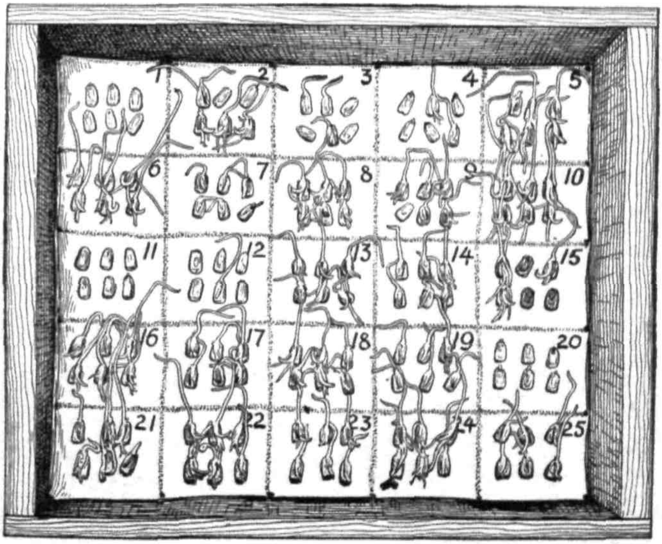

FIG. 42. — Germination test of different ears of corn. Discard ears 1, 2, 3, 4, 5, 7, 9, 11, 12, 15, 20.

fect seed. Those who are satisfied to grow an ordinary plant will not question the seed used. But others may be more ambitious. Through careful selection

of seeds, plants have been much improved. Improved oats gave 147.5 bushels to the acre, while unimproved produced 109.6 bushels.

FIG. 43. — This sunflower 15 feet tall shows what selection of seed and cultivation will do.

Good seeds. Good seeds should have a percentage of germination over 90; that is, 90 out of 100 seeds should grow. Ordinarily they should have been grown the previous year to be good seeds.

Buy standard varieties from reliable dealers. These varieties may be tested as follows: Place fifty seeds, taken at random from the package, between blotters and plates (or use the method shown in Fig. 42). If the seeds are small, omit the top blotter. Moisten the blotters and set the material aside. Note each day how many have sprouted. If the percentage of germination falls below 90, that is, if five seeds fail to germinate well, reject the seeds.

Ordering seeds. The following table will help you in ordering seeds:—

Seeds the size of

	Beans	1 qt.	to 100 ft. row.
	Onions	1 ounce	to 100 ft. row.
	Lettuce	½ ounce	to 100 ft. row.
	Radish	1 ounce	to 100 ft. row.
	Turnips	1 ounce	to 100 ft. row.
	Corn	1 pt.	to 100 ft. row.
Vegetables.	Peas	1 qt.	to 120 ft. row.
	Carrots	1 oz.	to 100 ft. row.
	Onion sets	1 qt.	to 50 ft. row.
	Parsley	1 oz.	to 125 ft. row.
	Parsnips	1 oz.	to 200 ft. row.
	Spinach	1 oz.	to 25 ft. row.
	Cucumbers	1 oz.	to 125 hills.

Seeds the size of

Vegetables.	Pole beans	1 qt. to 100 hills.
	Squash	1 oz. to 50 hills.
	Watermelon	1 oz. to 30 hills.
	Lawn grass	2 lb. to 200 sq. ft.
Flowers.	Nasturtium	1 oz. to 25 ft.

AVERAGE TIME REQUIRED FOR GARDEN SEED TO GERMINATE UNDER GOOD CONDITIONS

Kind of Seed	No. Days
Bean	5 to 10
Beet	7 to 10
Cabbage	5 to 10
Carrot	12 to 18
Celery	10 to 20
Corn	5 to 8
Lettuce	3 to 8
Onion	7 to 10
Pea	6 to 10
Parsnip	10 to 20
Tomato	6 to 12
Turnip	4 to 8
Radish	3 to 6

Sources of seeds. Often seeds may be obtained free from the government. Write to a congressman of your district and ask him to send you packages of government seeds. Test such seeds before planting.

Write to the State Experiment Station of your state, and the officers may send you free seeds. Your teacher will help you in this matter.

The school board, if asked, may furnish seeds for your school garden.

If you have room to spare in your garden, let a few plants of each kind furnish you with seed for the following year. In gathering such seed, select it from the strongest and most vigorous plants only. Good seed looks bright and plump. Good peas are green in color. Reject those light in color. Test pea seeds as indicated above.

Questions

1. What is the second step in growing a *best* radish?
2. What is meant by "Good Seeds"?
3. Explain a method of testing seeds.
4. What is the proper percentage of germination?
5. How may seeds be obtained?
6. Ask your teacher what corn growers have gained by selection of seed.

CHAPTER IX

PLANTING THE SEEDS

Preparation for planting. As has been suggested before, if possible, prepare the seed bed and plant the seeds at the same hour. If planting is delayed, sow the seeds and sprinkle thoroughly with a fine spray for several hours. Sprinkle the soil several hours before seeding, stir, and sow. This is another method; or fill the seed trench with water and plant the seeds after the water has soaked in. Often time may be gained by soaking such seeds as peas, beans, onions, etc., twenty-four hours before sowing.

FIG. 44. — A prize garden.

Squeeze a handful of soil taken from the seed bed. Open the hand. If the impression of the fingers is left in the soil, and if it

crumbles readily, it is ready for the seeds. Remember also that soil in such a condition does not need irrigation.

What to plant. Radishes, lettuce, onions, beets, carrots, turnips, and peas may be planted at almost any time in states where the winters are not too cold. Consult the vegetable calendar.

Cold weather vegetables. Asparagus, beets, cabbages, carrots, kohl-rabi, lettuce, onions, parsley, parsnips, peas, radishes, spinach, turnips, cauliflower, celery.

Warm weather vegetables. Beans, corn, cucumbers, egg plants, melons, peppers, pumpkins, squashes, sweet potatoes, and tomatoes.

Time of planting. The time of planting often determines the success or failure of a crop. In 63 trials early seeding of grain (before December 20 in California) produced an average crop of 44.39 bushels to the acre, while late seeding gave a crop of but 40.32 bushels.

Start sugar beets, flax, hemp, castor beans, cotton, and peanuts in separate beds. These may be harvested later for sugar, cloth fiber, etc. Remove the shell and use raw peanuts as seed.

How to plant a few common vegetables. Beets should be planted one to one half inches deep in rows, or drills, 12 to 18 inches apart, and about 18 seeds to the foot. Thin out to 4 inches apart. Do not let two or more beets grow close together. They will twine about each other. They mature in 3 to 5 months.

Marking the rows. There are three good ways to mark off the rows: (1) stretch a string where the row is to be, and dig the trench with a hoe; (2) lay down a rake with the prongs up, draw a hoe along the handle, thus making the trench, or step gently on the rake

FIG. 45. — Three ways of marking off the rows.

handle and make the trench along the impression left; (3) use a board as a guide, draw the hoe along its edge.

The figure illustrates the methods.

Always mark off the following row before the preceding trench is covered. One is a guide for the other.

Sowing. Hold the seeds in the left hand and sow with the right, pinching the seeds between the thumb

and the first finger. In planting, keep the hand close to the trench so as not to scatter the seeds. Having sown the seeds as directed, cover, and press down with the rake or hoe blade or with a board (Fig. 46). This presses the soil close to the seeds and hastens capillary

FIG. 46.—Two ways to firm the soil over the seed rows.

action. The water climbs quickly to the seeds. As soon as the plants are up, loss of capillary water should be stopped through cultivation.

At the head of the row, place a small stake labeled with the name of the seed and the date of planting. Later, as the plants appear, write the date on the stake.

It is a good plan to keep a notebook in which you may keep a record of your plants.

Seeds of the warm weather vegetables may be planted early in paper pots in the schoolroom. Later, pots and all may be placed permanently in the open. The paper will rot away, leaving the plants undisturbed. Cheesecloth may be used to force warm weather plants and protect them from frost at the same time.

Cabbage. Sow in boxes or in rows about three to an inch, and transplant when the true leaves have formed. Transplant 18 to 24 inches apart in rows. The rows should be 2 to 3 feet apart. Cabbage needs a great deal of cultivation. Manure worked into the soil insures a better crop. The plants will be ready for use in 3 to 4 months.

Carrots. Sow in rows 10 to 18 inches apart. Do not plant seeds too close in the rows, about 24 seeds to a foot. Thin to 2 inches apart. Cultivate a great deal. Ready in 4 to 6 months.

Corn. Plant 2 inches deep in rows 2 to 3 feet apart and thin to 10 to 14 inches. Cultivate often. Matures in 2 to 3 months (see Chapter XXXVI).

Kohl-rabi. Kohl-rabi has some of the characteristics of the cabbage and the turnip. Treat the same as cabbages. Ready in 4 months. Kohl-rabi is prepared for the table as are turnips.

Lettuce. Sow the seeds ½ inch deep in rows 10 to 12 inches apart, seeds about 36 to one foot. Thin to 6 or

8 inches. Lettuce may be sown broadcast and then transplanted. Cover with a frame 18″ high and as long and broad as is necessary, inclosed with cheesecloth (Fig. 47). This insures rapid growth and tender leaves. Lettuce heads well if the leaves are tied up with string.

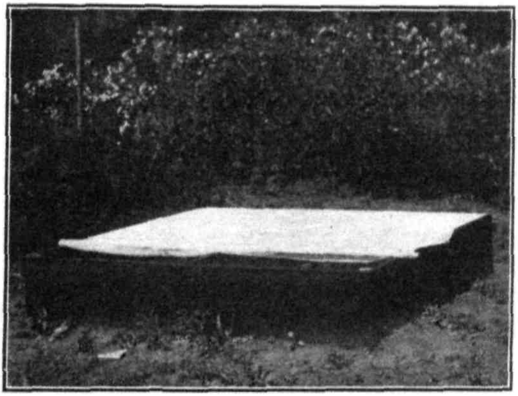

FIG. 47. — A cheesecloth forcing frame for lettuce and some other plants.

Spinach. Sow in rows 10 to 12 inches apart. Use for greens. Ready in 6 to 10 weeks.

Onions. Sow ½ inch deep in rows 10 to 14 inches apart, about 18 seeds to the foot in the row. Thin to 1 inch. The success of an onion crop depends on thorough cultivation. Ready in 2 to 3 months. Onions may be grown successfully as follows: (1) Broadcast the seeds in a bed, (2) cover with a manure mulch, (3) keep the bed wet, (4) transplant when plants are as

large as a lead pencil. Cut back the top and roots. We prefer the second method in school and home gardens.

Peas. Sow 2 to 5 inches deep in rows. Plant two rows 6 inches apart with a distance of 2½ to 3 feet between the pairs. The deeper planting should take place during the warm weather. Peas do best during the spring. Make a framework for the peas to climb on. Ready in 2 to 5 months.

Potatoes. See Chapter XXXV.

Radish. Sow ½ inch deep in rows 10 to 18 inches apart, about 24 seeds to a foot. Thin to 1 inch. For a constant supply, sow every 2 weeks.[1] Ready in 1 to 2 months.

Turnips. Give the same treatment as the beets.

Tomatoes. Sow early in the spring in boxes and transplant in rows 3 to 5 feet apart and from 3 to 5 feet apart in the row. Potting tomatoes, cabbages, and many other plants and later transplanting to the open insures excellent results.

Time of planting. The depth of planting varies. If the weather is warm, the soil light and somewhat dry, plant about 5 times the diameter of the seed, as a usual thing. Plant about 3 times the diameter of the seed if the weather is cold, the soil heavy and moist. By observing these rules, the seeds are more likely to re-

[1] Plant at different periods during the planting season if a continuous supply of other vegetables is desired.

ceive warmth, and they stand a better chance to reach the sunlight.

If you wish to know how to plant other vegetables, ask your teacher to write to the Secretary of Agriculture, Washington, D. C., for Farmers' Bulletin No. 255, "The Home Vegetable Garden," and for flower growing ask for Farmers' Bulletin No. 195, "Annual Flowering Plants." Possibly you had better write the letter yourself. Both bulletins are free.

Seed companies will send you catalogues telling how to grow plants.

Flower growing. Many flowers such as pansies, stocks, daisies, marigolds, cosmos, etc., may be planted in boxes under cheesecloth frames any time from September to March. The young plants thus get an early start and may be transplanted later. Boxes 3–4 inches deep should be used. If you take manual training, make a box, or flat, and a float for firming the soil as shown in Fig. 48.

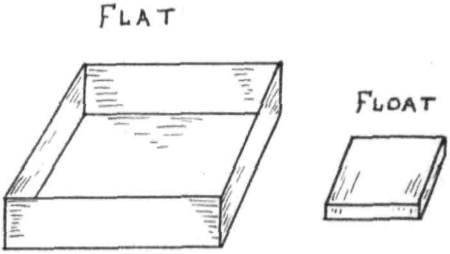

FIG. 48.

Preparation for planting. Mix thoroughly equal parts of sand, garden soil, and leaf mold. Place in the bottom of the boxes, or flats, an inch of gravel, or bits

of broken flower pots. This is to prevent water standing in the soil. Make a sifter by tacking wire screen to the frame of a box out of which the bottom has been knocked, and sift the soil for the surface. Moisten the soil after mixing, at least 24 hours before stirring

FIG. 49. — Preparing soil for growing flowers in a box.

and sifting. Do not stir the soil while wetting it. Let the soil alone until the next day.

Planting. Stir the soil thoroughly. Scatter fine seeds such as pansies on the surface. Use a smooth block of wood (the float), or a flat surface of some kind, and press the seeds gently in the soil.

If the seeds are larger than pansy seeds, they should be covered with soil to a depth of once their diameter.

Cover the box with glass or paper until the plants come up to prevent evaporation. Pansies do best if they are transplanted twice.

Flower seeds may be planted in the spring where they are to grow. Prepare the seed bed as directed for vegetables. Make the soil very fine on top. If manure is added, break it up and mix thoroughly with the soil.

Sow the seeds in rows at a depth about five times the diameter of the seeds. The rows should be far enough apart to allow trench irrigation and room for cultivation. Label each row. Seeds may also be sown broadcast. During warm weather flower seeds sown in the open should be covered with sacks or a straw mulch. As soon as the seeds germinate the covering should be removed, but do not let the bed dry out. Daily watering may be necessary.

Read in the Appendix the time to plant both flowers and vegetables and suggestions for flower gardens. Bear in mind color arrangement.

Questions

1. Explain a method for planting seeds.
2. How may you hurry the germination of seeds?
3. How may you tell if soil is ready for planting?
4. How may rows be made straight?
5. What is gained by pressing the soil over the seeds?
6. In general, explain how to plant cabbage, carrots, corn, kohl-rabi, lettuce, spinach, onions, peas, radish, turnips, and tomatoes.

7. How would you prepare soil for planting seeds in boxes?

8. Explain in detail how you would plant pansies in boxes. How would you plant the seeds outside?

9. Visit a "truck" gardener and see how he grows vegetables for the market. Visit a florist.

Home Studies

1. How does a farmer plant corn, wheat, potatoes, etc.? Does he plant by hand or by machine?

2. Which gives the greater production, a grain field sown by broadcasting seed or by "drilling"?

3. How does the farmer keep the seed rows straight?

4. What is a "hotbed"? How is it used by a gardener?

5. What is meant by "summer fallow"?

6. What is a "cold frame"? A "greenhouse"? What is their purpose?

7. The wheel tracks of a wagon which passed over a newly sowed grain field are always marked by a better growth of plants. Why?

Free Bulletins

See Chapter X.

CHAPTER X

CARE OF SEEDLINGS

The trench method of irrigation. Remember the motto, " Work the watering can less and the hoe more." If watering is *necessary*, use the " trench " method. *Do not sprinkle.*

Dig a deep trench with your hoe between two rows. Be careful not to disturb the roots of the young plants. Keep at least two inches away from the stems. Fill the trench full of water two or three times. After the water soaks in, cover the trench. Such watering will do for two weeks in most places, if the water is kept in the soil by cultivation.

The roots, as you have learned, seek water (Exercise 4, Chapter VI). With the trench method the water sinks below the roots, thus drawing them down. The plants with roots set well in the ground grow better and can withstand more hardships.

Sprinkling. Sprinkling usually waters the surface only. The roots grow near the surface (Exercise 4, Chapter VI). Plants with surface roots do poorly. If the plants are grown broadcast and you must sprinkle, be sure to really water the bed. Wet it completely *in the evening*. Exercise 6, Chapter VI, taught you this.

In the morning, when the surface begins to dry, hoe and rake to a depth of three inches, to keep the water from escaping. Be sure to cultivate your garden shortly

FIG. 50. — The right and the wrong way to irrigate a garden.

after a rain. Sprinkling plants each day is a sure way to spoil them. Never sprinkle when the sun is shining. Avoid sprinkling the plants themselves. Lettuce sometime refuses to head under such treatment. Some

plants need a great deal of water; others do not. Consult the calendar.

Watering flower seeds in boxes. If you moisten the soil well before planting the seeds and then cover the box with paper or glass, water will not be needed until the plants are well started. In sprinkling, use a fine

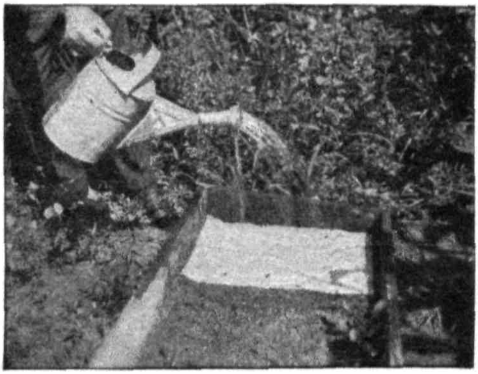

FIG. 51. — Sprinkling seeds in boxes through a piece of cloth.

spray so as not to wash out the seedlings. Sometimes it is a good plan to sprinkle through a cloth laid on the soil. Small seeds sown on the top should never be allowed to become dry. Drying usually kills a germinating seed. A dormant seed may lie for years and then germinate if moistened. Let such a seed dry out, and it may not germinate again.

Late care of the seedlings. Watch the plants closely. Do not give too much water, particularly during the

wet weather. "Damping-off" is a disease which often attacks seedlings that are given too much water. Subirrigation often prevents damping-off. A handful of sand, charcoal or fertilizer placed on the soil may prevent trouble.

FIG. 52. — A dahlia grown by disbudding.

If the young plants become spindling, they are too close together or need more light. Thin them out and place the box in a lighter place.

Plants try to produce seeds in order that more and better plants may grow. Seeds come after the flower. If a plant is allowed to go to seed, it usually stops growing flowers. If the flowers are picked before going to seed, the plant sends out new flowers. To keep your plants blooming, pick the flowers daily. The farmer has taken advantage of the plant's effort to produce seeds. Alfalfa is cut before going to seed, and a new crop forms. Alfalfa may produce four to seven crops.

Each flower on a plant needs food which the parent plant has to furnish. The parent plant can furnish more food to two flowers than to twenty. Therefore if you want to grow large flowers, pick all of the forming buds but a few. These will get a large amount of food and grow into large and beautiful blossoms. This process is called disbudding (Fig. 52).

Thinning out plants in the garden. With one foot on each side of a row, kneel and thin out the young plants as desired soon after the true leaves have formed. Thin out the smallest and weakest plants. Try not to disturb the remaining seedlings as you are thinning out the weaker ones. Those removed may be transplanted, given away, or carried to the poultry yard. The kind of root and the kind of stem and leaves a plant has, tell us how far apart to thin seedlings. Wheat roots run straight

FIG. 53. — Thinning out plants.

down without branching, while the corn roots branch and mass together. Thus wheat is grown close because of deep roots. Exercise 6, Chapter III, showed this. Corn is planted far apart because of surface roots which

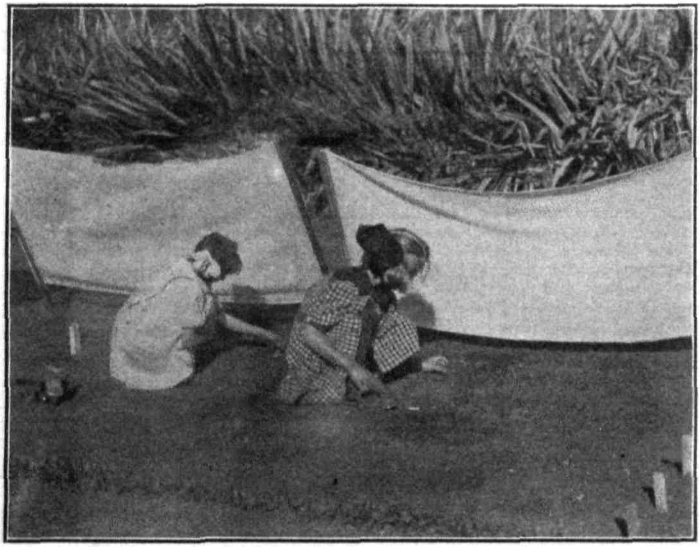

FIG. 54. — Transplanting. A cheesecloth frame used for shading.

would crowd each other. Plants with such roots as the beet are thinned to a distance equal to the diameter crosswise of the mature root. Lettuce and cabbage which form above ground should be as far apart as the distance across the mature heads. For example, as you have been told before, a lettuce head is about eight inches

across. There should be a distance, then, of eight inches between plants.

Transplanting. Seedlings may be transplanted after the true leaves form, or after the plants are two inches

FIG. 55. — Transplanting cauliflower.

high. Before removing the "seedlings," water them at least twenty-four hours before handling.

With a "trowel," carefully dig up a young plant. Be careful not to injure the tiny roots. Take up as much

soil as you can. Make a hole, where the plant is to grow, larger and deeper than the root space necessary. Insert the plant and the soil which clings to it without twisting or doubling the roots. Hold the plant with the left hand; pack fine soil around the roots carefully with the right. If the plant is quite small, pinch the soil about the roots. Water thoroughly or, better, water the soil the night before transplanting. After the first watering, use but little water. Too much water rots the injured roots.

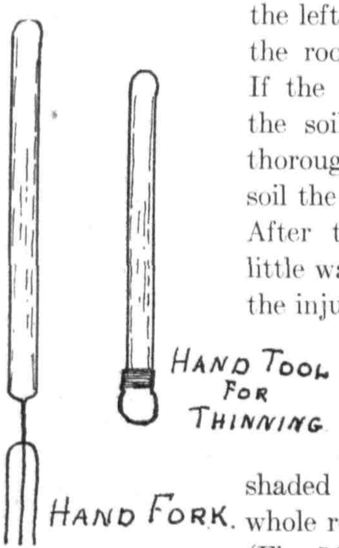

FIG. 56.

Transplanting should be done toward evening or on a cloudy day, and the young plants should be shaded with a large board for a whole row, with cheesecloth guards (Fig. 54), or with shingles, etc., for individual plants.

Stretch a string across the garden to guide you in making straight rows.

Transplanting usually strengthens the plant. A larger root system is formed. It tends in many cases to dwarf, or reduce, the plant's size.

Cultivation. Cultivation prevents the capillary, and hence the gravitational, water from escaping. Exercise

7, Chapter VI, taught you this. It prevents a crust forming on the surface of the soil which would shut out soil air and would prevent the young plants from getting out of the ground. It breaks up the soil so that air may enter. It keeps the soil fine, and the

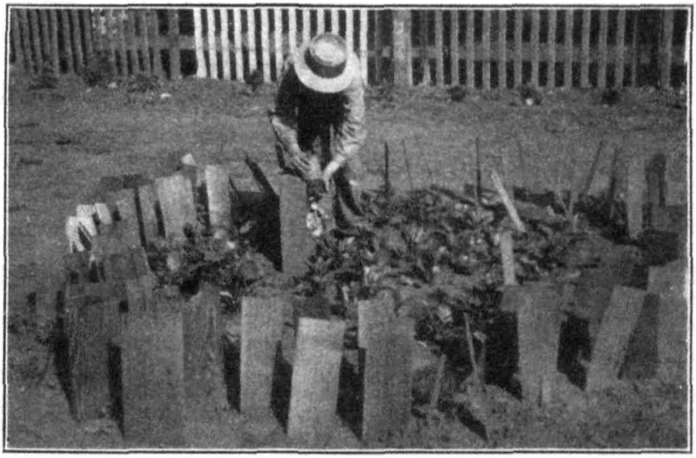

Fig. 57. — Transplanting from pots. Let the plant project through the fingers. Thump the inverted pot against a hard surface. With a little care the plant may be moved with no set-back. Shade with shingles.

roots grow rapidly. Cultivation keeps the weeds out. In cultivating use the hoe, or rake vigorously around the plants, but do not work closer than two inches to their stems. Figure 56 shows a hand tool which may be used in breaking the soil between the plants in a row and one which may be used to thin out small plants.

The third and fourth steps in growing the *best* radish are proper thinning, proper watering, and a great deal of cultivation.

Questions

1. Explain the "trench" method of irrigation; the flooding method.
2. Why are these methods better than sprinkling?
3. If sprinkling seems necessary, when should it be done, and why?
4. How would you water flower seeds sown in boxes?
5. What is the danger of overwatering?
6. What may make seedlings spindling?
7. Explain how you thin out plants.
8. What is the main effort of a plant? How has the farmer taken advantage of this fact?
9. What steps would you take to grow an extra large flower?
10. Give the steps in transplanting.
11. What effect has transplanting on the seedling?
12. Of what use is cultivation?
13. What are the third and fourth steps in growing the best radish?

Home Studies

1. How does the farmer cultivate his fields? What tools does he use? Does he cultivate enough?
2. What is "hardpan"? What effect has deep and shallow cultivation on hardpan?
3. Do the orchardists in your vicinity flood their orchards?
4. What plants do best when transplanted?
5. Learn something of dahlia and chrysanthemum culture.

FREE BULLETINS

Tomatoes — Farmers' Bulletin No. 220.

Cucumbers — Farmers' Bulletin No. 254.

The Home Vegetable Garden — Farmers' Bulletin No. 255.

Preparation of Vegetables for the Table — Farmers' Bulletin No. 256.

Flax Culture — Farmers' Bulletin No. 274.

Celery — Farmers' Bulletin No. 282.

Beans — Farmers' Bulletin No. 289.

Strawberries — Farmers' Bulletin No. 198.

NOTE. Start Exercise 2, Chapter XIV.

REVIEW QUESTIONS ON CHAPTERS VI TO X INCLUSIVE

1. Why should fertilizers and irrigating water work best, deep in the soil below the young roots of a plant?
2. How may water be held in the soil?
3. Give a general rule for the depth to plant seeds.
4. What should determine the choice of a garden plot?
5. Tell how a home might be beautified.
6. How does a farmer prepare a field for planting?
7. What is gained by seed selection?
8. Why should soil be firmed above a seed row?
9. Why should the young plants be thinned out early?
10. Explain the processes used in growing a pansy.
11. Which is better, to drill or to broadcast seed?
12. What might be gained by rolling a wheat field immediately after planting?

CHAPTER XI

WINDOW BOXES

IF you have not a garden at school or at home, try to have an inside, or an outside, window garden.

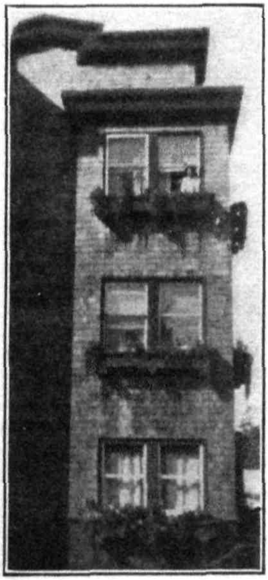

FIG. 58. — Window boxes add to the appearance of a home.

Size. In your manual training work, either at home or at school, make several boxes out of redwood or pine, 6 to 8 inches deep, 12 to 15 inches wide, and as long as the windows. If you wish, make holes in the side through which hanging plants may be trained.

Soil. See directions for planting flowers in boxes (page 67).

What to plant.

Window box No. 1: On the side nearest the house, for an outside window garden sow a climbing plant such as a morning-glory. Sow climbing nasturtiums or some similar plant on the far side and train them to hang through the holes or over the edge. In the center, plant some flower which you admire. It may be ver-

benas, petunias, calliopsis, asters, stocks, or some other hardy grower.

Window box No. 2: Plant bulbs in October — hyacinths, tulips, narcissus, jonquils. Sow low-growing sweet alyssum among the bulbs.

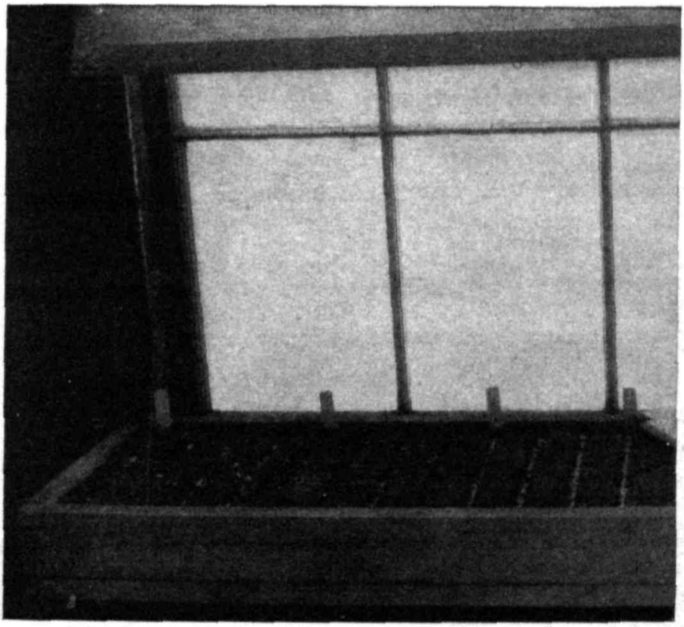

FIG. 59. — Inside window box.

Window box No. 3: Sow scarlet verbena seeds and lobelia seeds in boxes early in the spring. Transplant to the window box. Put the lobelias in front for a border.

Window box No. 4: Put ferns in the box which is shaded.

Window box No. 5: Train morning-glories over the front of the box, letting them hang over the edge. Grow dwarf nasturtiums in the rest of the bed.

Window box No. 6: Start geranium cuttings in sand. Plant smilax and daisy seed in boxes. When the plants are doing well, plant the smilax at the back, the daisies in front, and the geraniums in the center. This combination requires a wide box.

Window box No. 7: Plant red geraniums at the back and lobelia in the front.

Distance apart. Thin the plants to about four inches apart.

A mysterious garden. Fill a box with garden soil and water each day. Soon young plants will begin to show, growing from seeds which were in the soil. Try to identify the seedlings as they appear. Ordinarily, such a box furnishes a new surprise each day as the plants begin to come up. Try to account for the presence of the seed in the soil. How did each seed get there?

Questions

1. Explain how to make a window box.
2. How should the soil be prepared?
3. What would you grow in such a box?
4. Which side of the house is best for such a box?

Note. Start Exercise 1, Chapter XIV.

CHAPTER XII

BEAUTIFICATION OF THE SCHOOL GROUNDS

ONE hundred hands went up in answer to this question put to 100 children, "How many enjoy flowers and trees?" Yet the school yard had not a tree nor a flower in it. Do *you* like flowers and trees? Are there any in *your* school yard? Are you proud of the beauty of your school? Are you proud of the homes in your vicinity? If not, why not do something to-day to beautify your school and its yard? Make this attractive, and many of the parents will beautify their homes.

A business man was getting farther and farther in debt. His goods could not be sold. Each day as he went to work he passed a beautiful hawthorn tree covered with red blossoms. Each day it gave him courage, and finally he succeeded in business. Flowers in the school yard will give you joy and courage.

The plan. Consider the following suggestions regarding landscape architecture, and draw up a plan for the whole school yard. Do not try to do all the work planned the first year. Some of the suggestions are repeated from Chapter VII.

Paths. Make as convenient as possible a few paths. They should be made on large curves. Join the door

and the place of entrance to the yard with curved paths.

Natural features. Use to advantage clumps of trees, a large rock, a stream, and any other natural features.

Keep the central part open. If a lawn is to be started, do not break it up with trees, shrubs, and flowers. Let there be a solid mass of green. Flowers may edge the lawn or be placed in mass at an abrupt turn in a path.

Borders. The open space should be bordered thickly with shrubs and trees. Scatter them irregularly. Plant the shrubs about 3 feet apart. (See Chapter XXX on "Trees.")

The general plan. On a piece of paper first make an outline drawing, considering the suggestions given (Fig. 60).

Details of the plan. Join the schoolhouse to the ground with vines. Hide the outbuildings, fences, etc., with climbing plants, or tall growing flowers, keeping in mind harmony of colors. Make arbors and shady spots for resting places. Mass flowers around the schoolhouse. Grow both annual and perennial flowers. Start window boxes.

Each pupil should make a plan. You should then select with the teacher the best parts of each drawing and together draw a permanent plan, indicating where each plant is to be grown. Tack the plan to the wall, or, better, put it in the hands of the trustees or school-

board so that a little may be accomplished each year. Each term *do something* to complete a part of the plan.

How to make a lawn. Plow or spade the ground, working in dry manure or bone meal or both. Rake

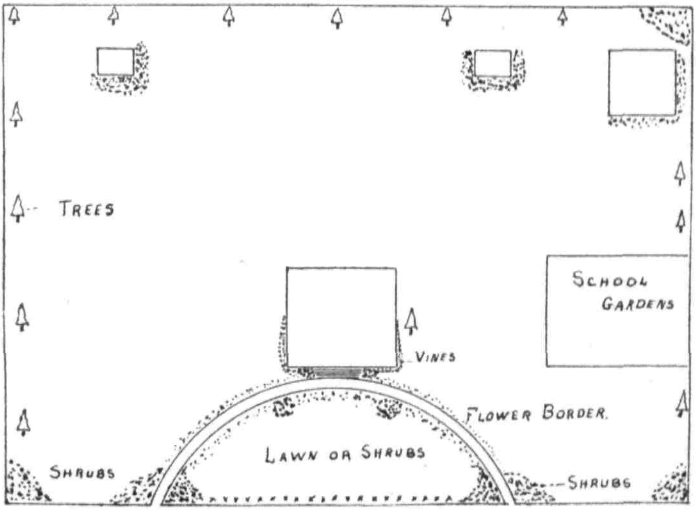

FIG. 60. — A plan for a school yard.

and form the plot until it is slightly higher in the center than at the edges. It should slope gently to the south.

Sow blue grass, Bermuda grass, or clover (1 pound to 100 square feet) broadcast. This may be done some time before the rains in September and October, or early

in the spring. Rake the seeds into the soil, and if a roller can be found, use it. Sprinkle *each evening.* To secure an even stand, keep the seed bed uniformly moist.

As the plants commence to come up, pull out the weeds, or, if allowed to grow, mow as the plants grow high

FIG. 61.—Elevation of Fig. 60.

enough. Most weeds are annuals; that is, they die each year, while lawn grass does not.

Water the lawn in the evening only, and then soak it. Turn on the water and let it run until the water penetrates several inches. Light sprinkling causes surface roots. A thorough soaking in the evening once a week during the hot weather is far better than sprinkling each day.

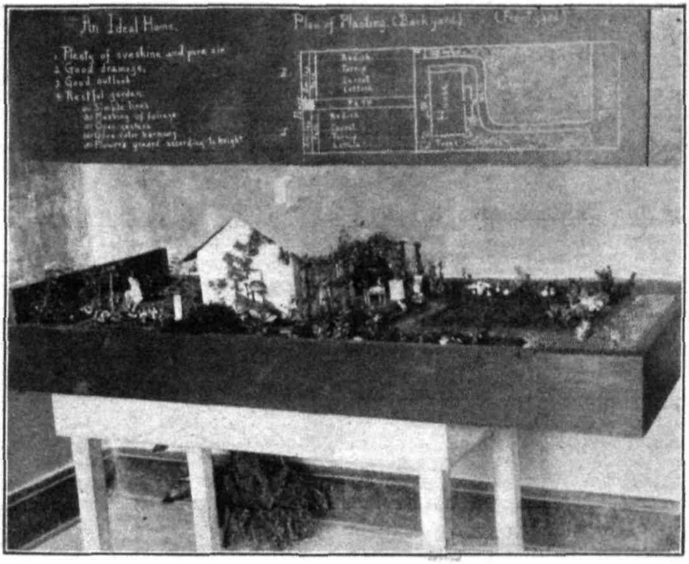

FIG. 62. — A miniature city home.

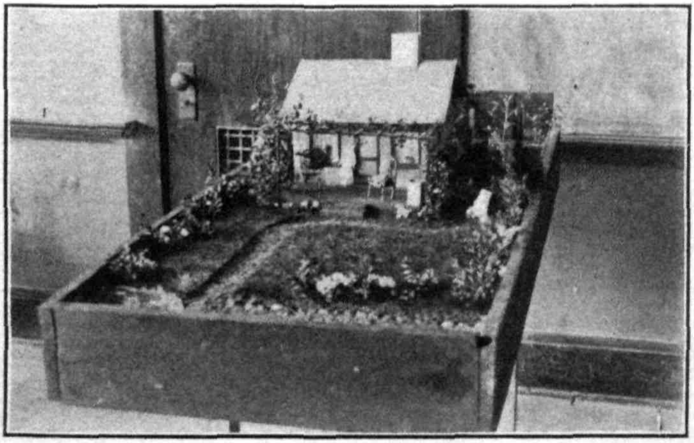

FIG. 63. — Front view of a city home.

The plants may not grow in spots. Rake such places and plant more seeds.

An old lawn may be made over by raking in bone meal or wood ashes and sowing new seeds.

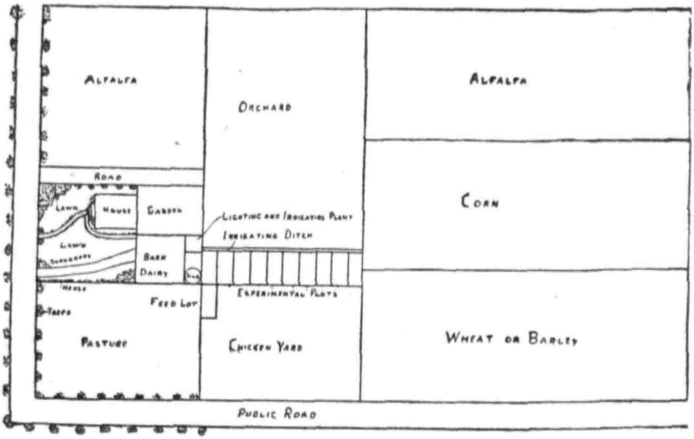

FIG. 64. — Plan for a ten acre farm.

Ask your teacher to let you make a sand and dirt table for the schoolroom. Make it about 4 × 6 feet and 6 to 8 inches deep. Fill it with equal parts of sand, clay, and garden soil. With your teacher and classmates form your schoolhouse and school yard on the table in miniature, according to your plan. Or plan an ideal city home for the same place. (See Chapter XLI.) Make the buildings of cardboard. Start the lawn, flowers, and trees. Use pebbles and sand for the roads and the paths. Score your schoolhouse, using the score card given in this chapter.

Later fashion an ideal ten or twenty acre farm on the table (Figs. 64 and 65).

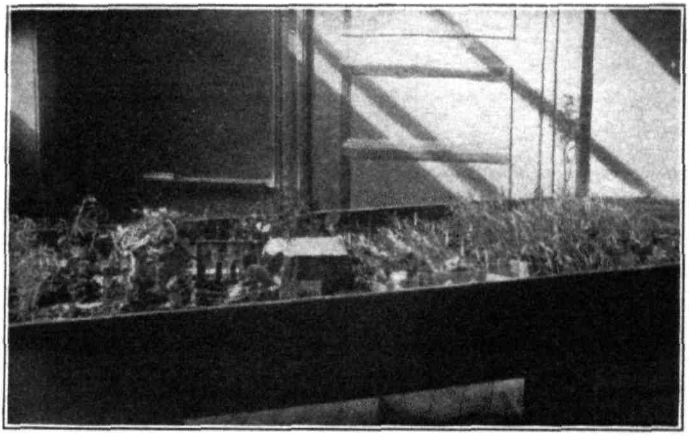

FIG. 65. — A miniature ten acre farm.

SCHOOLHOUSE AND SCHOOL YARD SCORE CARD

Situation	
Good drainage	2
Pleasant surroundings	2
Protecting hills and trees	1
Porous, fertile soil	3
Three acres of land	4
Easily reached by pupils	2
The Schoolhouse	
Located at south end of yard, faced towards the south or the west	2
Fireproof building if city school (rural school 4) . . .	4
Most of the windows placed so as to receive sunlight a good part of the day	2
Glass surface of the windows equal to at least ⅕ of the floor space of each room	2
Principal light of each room to come from the left of each pupil from the northeast, east, or north . . .	2

Window sills $3\frac{1}{2}$ or 4 feet from floor	1
No blackboards or wide spaces between windows	3
Inside	
Rooms oblong	1
Ceilings at least 12 feet high	3
At least 20 square feet of study room to each pupil	2
Rooms on one side, wardrobes, etc., on the other	2
Wardrobes open to sunshine and air	2
Rooms heated by furnace or jacketed stove drawing cold air from the outside	2
Rooms well ventilated	4
Rooms tinted to rest the eyes	2
Flowers growing	2
Pictures on the walls	2
Good curtains	2
Good library	3
Paper towels — individual towels	4
Hygienic drinking fountain	4
Liquid soap	2
Rooms clean	3
Hygienic sweeping and dusting (sawdust), vacuum cleaning	2
Outside	
Artistically planned and painted	2
Window boxes with flowers	2
Vines tying the house to the yard	2
Shrubs and flowers massed against the building	2
The School Yard	
An open lawn	2
Curved paths	1
Flowers, shrubs, and trees arranged for beauty and convenience	3
Playgrounds — $2\frac{1}{4}$ acres	4
School gardens — $\frac{3}{4}$ acre	4
Hygienic outbuildings hidden with vines and shrubs	3
Neatness and cleanliness of yard	3
Total	100 %

Questions

1. What is gained by making a plan for the whole yard at first?
2. How should paths be made?
3. What should be done with the central portion of the yard?
4. Where should trees and shrubs be placed?
5. Name some uses for vines and flowers.
6. What are annual and perennial flowers?
7. Describe the steps in making a lawn.
8. How may an old lawn be made over?
9. Observe the homes in your region. How might they be improved? What about your own home?

Home Studies

1. What should be considered in selecting an ideal location for a farm?
2. What buildings, tools, machinery, are necessary for an ideal farm?

Free Bulletins

Beautifying the Home Grounds — Farmers' Bulletin No. 185.

The Lawn — Farmers' Bulletin No. 248.

CHAPTER XIII

A CONVENIENT RURAL HOME

EACH boy and each girl who lives in the country wishes at some time to leave the rural home and to go to the city. There are no theaters, no places for games, no one with whom to play games in the country. Parents are so busy drudging day after day that

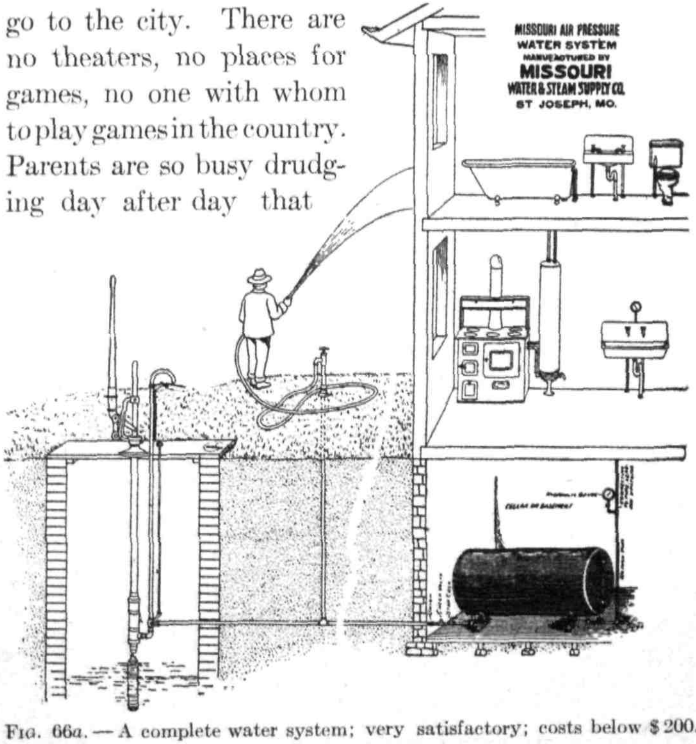

FIG. 66a. — A complete water system; very satisfactory; costs below $200.

they forget their children wish to play more and work a little less. Again, in the city, there is money in evidence on every side, and every one desires money, including the farmers' boys and girls. It is hard to get money for new hats and dresses in the country, for a new wagon or plow is needed.

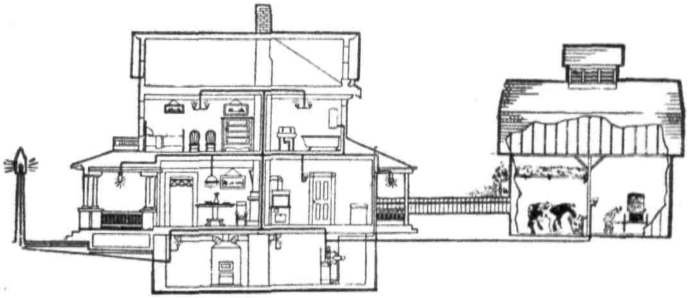

FIG. 66*b*. — An acetylene gas lighting plant. Costs about $125. Running expenses are less than the use of kerosene.

The city cousin brings distress to the country cousin, for the visitor tells of parties, new dresses, new hats. She sings the latest songs and wonders at the lack of electric lights, bathroom, and other home conveniences.

While the city boy appears to enjoy himself more, the country boy has the better place to live. The country boy has better health and usually has a better mind. As a man on his own farm, he is "master of all that he surveys." He makes more money and is far more independent than the city man who works for wages. With his automobile, his up-to-date farm, his convenient home buildings, the farmer is the chosen man.

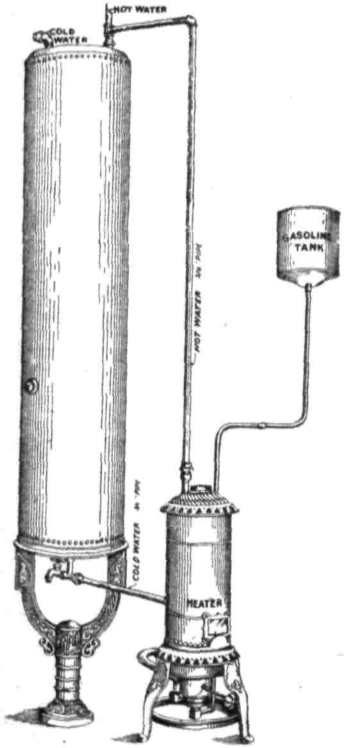

Fig. 66c. — A hot water arrangement which costs about $25.00.

Already many farmers have automobiles and labor-saving machinery, but the homes are sadly inconvenient.

The farm machinery against the labor-saving devices in the house: Machinery for an ordinary grain farm: —

Mowing machine . .	$70
Rake	35
Gang plow	85
Hand plow	18
Drag harrow . . .	20
Disk harrow . . .	50
Drill	145
Hay derrick . . .	100
Hay fork	40
Total	$563
Combined harvester .	2500
	$3063

Conveniences in an ordinary farmhouse: —

Sewing machine	$50
Wringer	3
Cooking stove	12
	$65

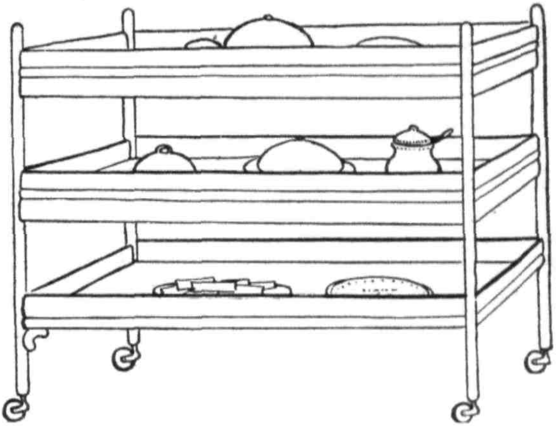

FIG. 66*d*. — An inexpensive dinner wagon. Saves steps between kitchen and dining room.

The farm home is neglected.

The Country Home as it might be against the ordinary City Home: —

Country Home		City Home
Sewing machine	$50	$50
Wringer	3	3
Cooking stove	12	12
Complete water system, including bath, etc.	125	125
Heating system for 8-room house	200	200
Lighting system complete for 8-room house	150	150
Vacuum cleaner	8	8
Refrigerator	15	15

Washing machine	$6		$6
Dish washing machine	15		15
Alcohol iron	5	Electric iron	5
Carpet sweeper	3		3
Bread mixer	3		3
Cake mixer	1.50		1.50
Meat mill	1.50		1.50
Fireless cooker	10		10
Coal oil stove	5	Range	50.00
Cement walks	25		25
Dinner wagon	5		5
Kitchen material such as paper towels, aluminum ware, steam cookers, etc.	20		20
Graphophone and records	60		60
	$723		$768

Thus at small cost the rural home may be made as convenient as the city home.

Questions

1. What is the cost of a complete water system in a rural home? Lighting system?
2. Name some of the conveniences which might easily be added to a rural home.
3. Why is the farm home usually so inconvenient?

Home Studies

1. How may farm life be made more attractive?
2. Estimate the amount of money spent the last year on the farm nearest you for making the work of the farmer lighter — the work of the farmer's wife lighter.

CHAPTER XIV

PROPAGATION OF PLANTS

Exercises

1. Cut two or three stems from a geranium and place in a bottle three quarters full of water. Note results. (3 wk.)

2. (*a*) Twist a wire tightly around a young seedling. (*b*) With your knife remove a piece of bark $\frac{1}{8}$ inch wide from around a young tree. Note results from day to day. (3 wk.)

You have learned how to grow plants from seeds. Many plants are grown without planting their seeds, and some do much better. Plants are "propagated" or "multiplied": (1) by cuttings — roses, geraniums, grapes, currants, etc.; (2) by layering — blackberries, raspberries, etc.; (3) by division of tubers — dahlias, potatoes, and of bulbs — lilies, hyacinths; (4) by budding and grafting — fruit trees, etc.

Cuttings. Select sturdy growths of last year. Test the branches by breaking until some are found which break with a slight report, leaving no jagged edges. Stems which bend and double are too young; those that break leaving splintered edges are too old.

With a sharp knife cut the stems off just below a bud. Make the cuttings about eight inches in length.

Fill a box with sand. With a pencil or your finger make holes in the sand and insert the cuttings from three to six inches, leaving a bud or two exposed. Be careful not to bruise the stems in inserting. Pack the sand around the cuttings. Make a small nail hole

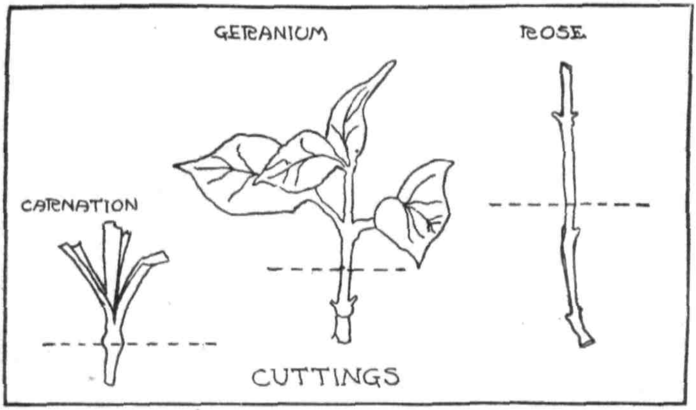

Fig. 67.

in a can, fill with water, and let a small stream of water run on the cutting. This washes the sand close to the stem.

A few days later if a cutting is turning black, replace with a fresh one. Keep the sand moist with a *fine* spray, but not soaked.

When the buds begin to appear, break off all but one or two, thus forcing all the strength into them.

The cuttings may be transplanted and potted as soon as two or three leaves form and the roots develop.

Layering. This is an easy way to rear a plant.

Bend a branch to the ground. Hold it in place with a pin of some kind. Cover the portion next to the ground with soil. After the stem takes root, it may be cut from the parent plant, at x, and transplanted wherever desired.

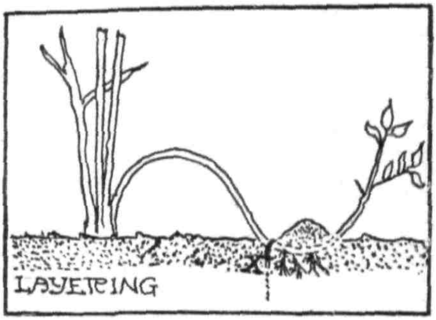

Fig. 68.

Propagation by tubers. A potato is a modified stem. When propagating potatoes, cut them in two lengthwise and plant one section to a hill. They may be grown by quartering the tubers and planting two pieces to a hill. Propagation takes place through the "eyes."

Bulbs. A bulb is a short underground stem, a thickened part of a plant which is a storehouse for food. Roots grow from its lower surface. Above it is covered with thick scales. Because of its stored food, the plant may be carried through the winter, and it will spring into growth with the coming of the warmth and rains of spring. The buds which grow from the parent may be separated and planted, making new plants.

The best varieties to plant are hyacinths, tulips, narcissus, and lilies. The best soil for an outdoor bulb

garden is a sandy loam that gives ready drainage and does not receive too much sunlight.

Well-rotted stable manure should be worked into the soil to enrich it, but avoid direct contact of fertilizer

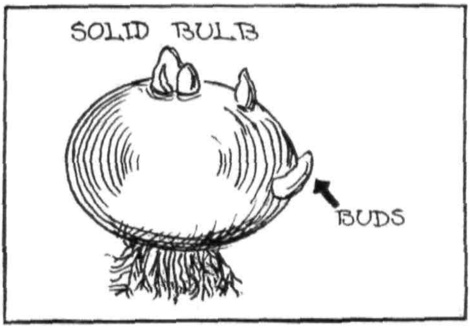

FIG. 69.

and bulb. Most bulbs like rich food, and the proper development, brilliancy, and beauty depend upon the amount of nutriment the roots consume. Liberal applications of manure water produce excellent results. The following table should determine proper depths and distances for planting: —

BULBS	IN. DEEP	IN. APART	BULBS	IN. DEEP	IN. APART
Anemones .	2	6	Jonquils .	5	6
Crocuses .	3	2	Tulips . .	6	5
Snowdrops	4	3	Hyacinths .	6	7
Scillas . .	4	3	Narcissus .	8	12
			Lilies . .	8	12

After the soil has been prepared to a depth of some 15 inches, a very good general rule for planting bulbs is to plant twice their depth. Make the hole with a trowel, and if the soil is heavy, place a handful of sand at the base of the bulb. This will assist the roots and prevent the bulb rotting. The crocus may well be used when planted close together as edgings. A continuous display can be had by alternating daffodils, tulips, and Spanish irises, placing the bulbs about two inches apart. Daffodils will bloom first and will be followed by the tulips and irises. Forget-me-not, or lobelia, planted in boxes in the fall, and set out between tulips, daffodils, or hyacinth bulbs, as soon as they appear above ground, makes a pretty effect.

If bulbs are to be potted, prepare potting soil of loam, leaf mold, and sand in equal parts. If it is difficult to secure pots for the plants, tin cans may be used. Plant the bulbs generally so that their tops just appear at the surface. To encourage root development, bury the pots to the depth of six inches and leave for four or five weeks. After this period of root setting, warmth and water will cause the bulbs to flower. Plenty of liquid manure should be applied after the flower spikes appear.

Single hyacinth and some other bulbs grow nicely in glasses. Place the bulb so that the base merely touches the water. Set the jar in a cool, dark, airy place, until the roots have had a chance to develop. Bring the bulb to a cool, shady place and it will soon

flower. As the water evaporates, fill the jar, and when necessary, to keep water sweet, make a complete change. A small piece of charcoal placed in the water will help to keep the water pure. A little nitrate of soda or saltpeter dissolved will hasten the growth. Often the hyacinth flower begins to open before the stalk forms. A paper cone inverted over the plant will help the stalk to grow.

Chinese lily bulbs may be made to flower luxuriantly as follows: Remove the brown scale at the base of the bulb, but do not remove the small bulbs. Gash the bulb from the top downward almost to the base. Make four gashes, cutting half an inch deep if the bulb is large. Cut a couple of gashes a quarter of an inch deep in each small bulb. Plant the bulb in the manner described above.

After the flowers have died down, late in the spring, the different varieties of bulbs should be lifted and put away in dry sand, and very often they can be used again in the fall or they may be left in their beds without water.

Questions

1. Name several ways of propagating plants.
2. What is gained by propagating a plant by slips?
3. Tell how to make a rose cutting; a carnation cutting.
4. How may strength be thrown to one branch or bud?
5. What is meant by layering?
6. How are potatoes grown?
7. What is a bulb?
8. Explain how to plant and how to care for bulbs.

Home Studies

1. Visit a greenhouse and note the methods used for propagating plants.

Free Bulletins

Grape Propagation, Pruning, and Training — Farmers' Bulletin No. 471, U. S. Department of Agriculture, Washington, D. C.

The Propagation of Plants — Farmers' Bulletin No. 157.

School Exercises in Plant Production — Farmers' Bulletin No. 408.

CHAPTER XV

PROPAGATION OF PLANTS (*continued*)

Exercises

1. Follow directions given in this chapter; bud and graft rosebushes before treating young fruit trees.
2. Visit orchards. Note correct and incorrect pruning. Are the trees well shaped?
3. Remove the bark carefully from a willow stem. Scrape the stem. The soft filmy tissue is a part of the cambium layer.

Budding and grafting. Somewhere in the garden you should leave a long, narrow strip of ground for a nursery. The plot should be at least 3 feet wide and 20 feet long.

Many fruit trees, such as peach, almond, etc., may be started from the seed. Young apple trees may be started by "piece roots" — sections of roots. (See Appendix for directions for starting shade trees such as acacias, walnuts, etc.)

Fruit trees reared from seeds and allowed to bear may produce very poor fruit. By processes called budding and grafting, you can make a young tree — for example, a peach tree — grow the kind of peach that you wish.

HOW TO GROW A PEACH TREE

The seed. From a nurseryman get a few seedling pits or pits from the ordinary peach tree. It is a good plan to dip the pits in " blue stone " water before planting. Plant the seeds 4 to 6 inches deep in rows 6 inches apart, early in the spring.

The seedling. If you wish to gain a year's time, buy young seedlings from the nurseryman that have not been budded or grafted. Either plant them where they are to remain permanently, or close together. After budding or grafting they may be used as you see fit.

Budding. In Exercise 3 the cambium layer was pointed out. It is tender growing tissue between the

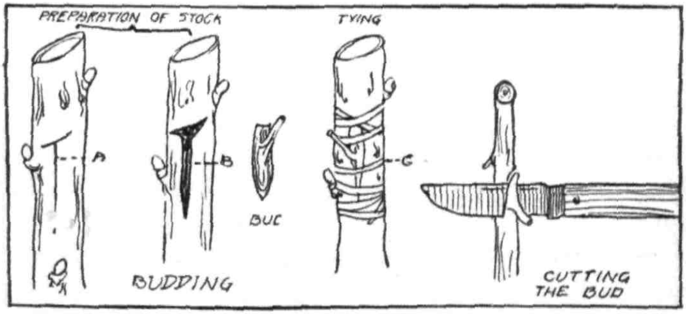

FIG. 70.

bark and the wood. In the spring it is so filled with sap the bark seems loose. Willow whistles may be made in the spring, because the bark loosens at the cambium layer. It is filled with nourishment for the plant.

Exercise 2, Chapter XIV, pointed out that the plant lives on the food brought to it in the sap. Since this is true, you can do much to grow a strong, vigorous tree by pruning, disbudding, and fertilizing.

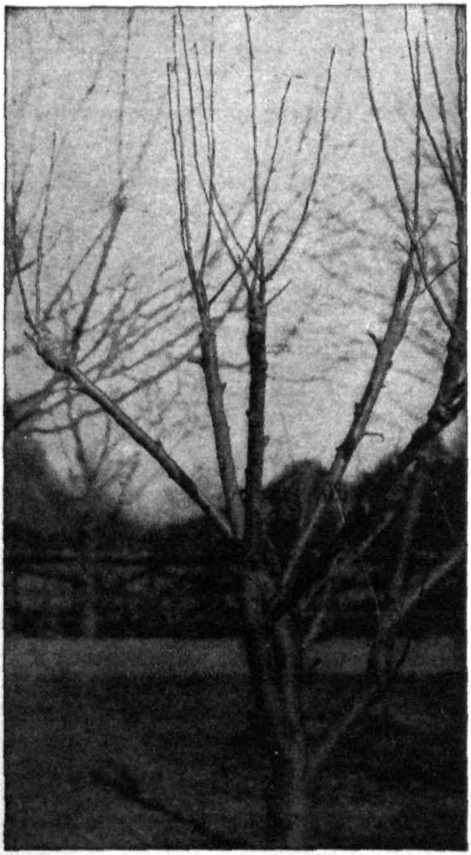
FIG. 71. — Cleft grafting to improve the variety.

After your seedling is a year old, decide what kind of peaches you wish to grow. From an orchard growing the peaches desired, cut off a few branches bearing buds. Cut only the outer bark of the stock, as in Fig. 70. Carefully roll or loosen the bark without bruising cambium layer. Slip in bud, bind in place. Break over the young tree (Fig. 74).

Bud your seedling as you budded the rosebushes in Exercise 1. After the bud "takes," cut away the string and the broken part. At the end of the second year cut off the heel (Fig. 75.)

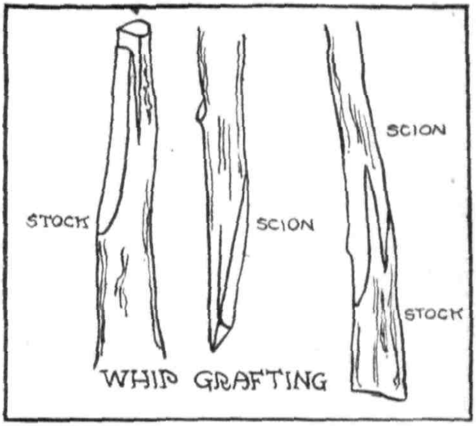

FIG. 72.

Grafting. Some of your seedlings should be grafted. (See Figs. 72 and 73.) After practicing on the rosebushes, Exercise 1, treat your seedlings in a similar way. In grafting, be sure that the cambium layers of scion and stalk are touching. Cover the place of union

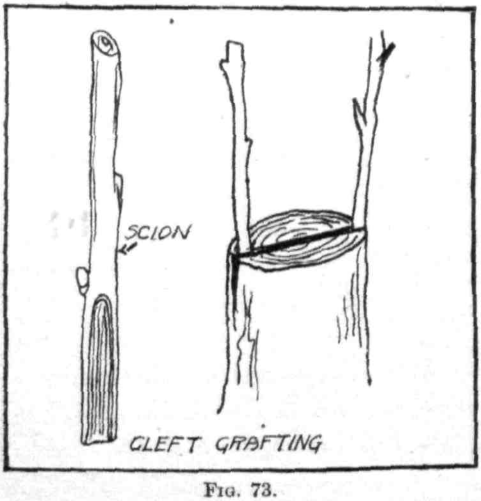

FIG. 73.

with grafting wax. Ask your teacher how to make this wax. The best time to graft is when the scion and stalk are dormant, not in leaf.

Planting and pruning. Directions for planting trees are given in Chapter XXX, and the Appendix.

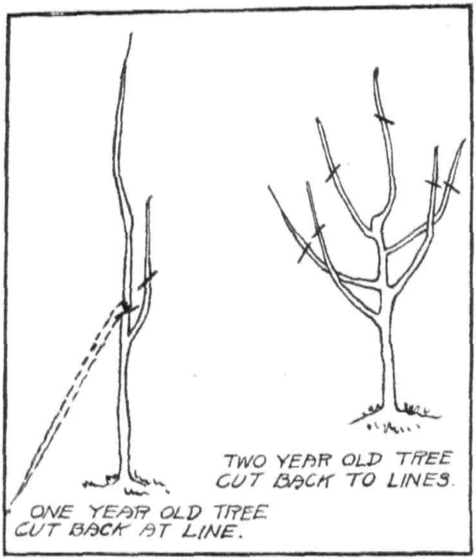

FIG. 74.

Pruning gives a tree shape and results in better fruit, for the sap containing food is forced into fewer branches, and, again, the growth of the trees as a whole is checked. Sometimes when trees are attacked by disease they are cut back to save them.

After a tree is one year old, it should be cut back, as shown in Fig. 74. This will drive out lateral or side branches.

If the tree is purchased from a nurseryman, the lateral shoots and the roots should be pruned as pointed out in Fig. 76.

Lateral branches should be pruned close to the stem, as indicated in Fig. 75. Soon the cut will heal. If pruned as shown in I, in same figure, the branch rots, water enters the stem, or trunk, and often the tree dies. A tree surgeon is one who watches and fills openings in trees with cement and who treats diseased plants by surgery. These openings are caused by wrong pruning, and by branches breaking.

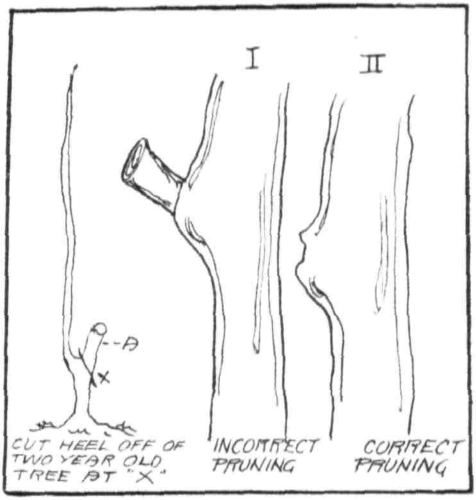

FIG. 75.

Figure 77 shows a tree which has been pruned properly. By cutting off the end buds (*a*), growth took place at the lateral buds (*b*), and by cutting back the side buds (*b*), growth took place at (*a*). Thus the tree was balanced. It lets in plenty of light for the development of the fruit, and is shaped so that the fruit may be obtained easily.

PLOWING THE NEW ORCHARD

Plowing. Plow the orchard after the first rain, so that the rainfall may be conserved. The rough clods will catch the rain and so prevent surface water from running away to the streams. As the volunteer growth of weeds, burr clover, and the like attains a vigorous growth, plow it under. The vegetable matter adds nitrogen to the soil, aids in capillary action, and tends to hold moisture in the soil. Plow to a depth of eight inches with a disk plow (Fig. 79).

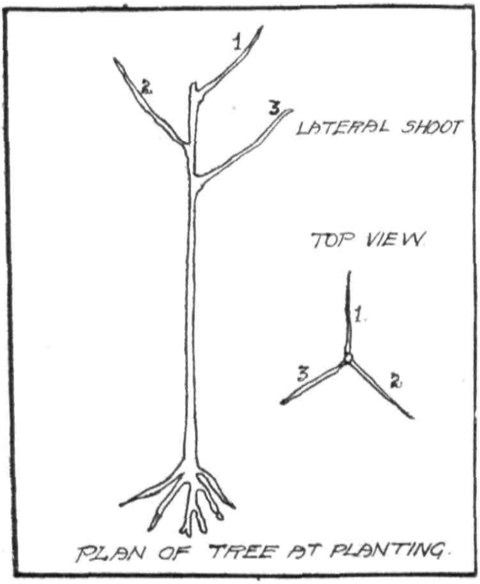

FIG. 76.

Harrowing. Immediately after plowing, use a disk harrow (Fig. 80) and a clod masher to pulverize the turned-over soil. Next to the plow, the disk harrow is the most valuable tool used on the farm. It breaks

up the humus matter, packs the surface soil — the newly turned soil—firmly to the subsoil, and helps to kill weeds, besides crushing the clods. When the harrow is not set too deep, it may be substituted for a roller in packing the seed bed.

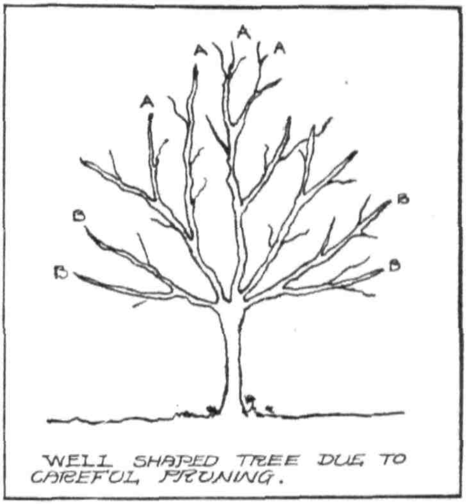

FIG. 77.

Rolling. Unless the newly turned sod is packed to the subsoil, and the capillary tubes of both are in union, the soil containing the seeds drys out and the plants may suffer from drought since the capillary water will not come up from the subsoil. Rolling packs the soil and makes the capillary tubes fine. Rolling the soil tends to bring the capillary water to the surface. To prevent its escape, use the disk harrow after rolling. The harrow breaks the capillary tubes near the surface and fills them with a dirt mulch. The harrow should follow the roller. Roll and harrow the orchard often during a dry season.

FIG. 78. — Ideal tillage in a profitable apple orchard.

Fertilizing. Grow red clover, alfalfa, or other "leguminous" plants during the rainy weather and plow under the crop as the dry weather approaches. This adds nitrogen to the soil, brings plant food to the

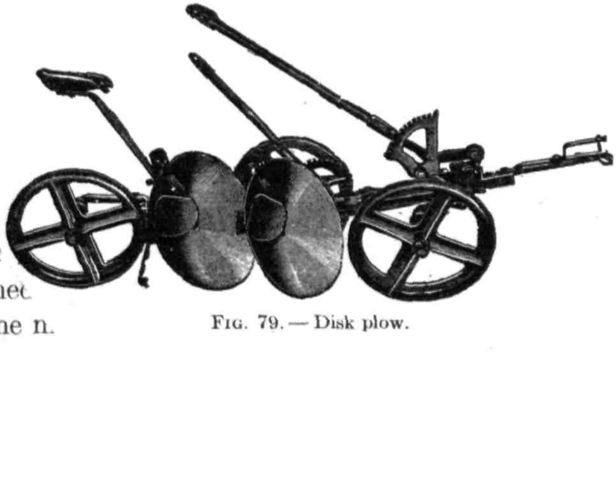

FIG. 79. — Disk plow.

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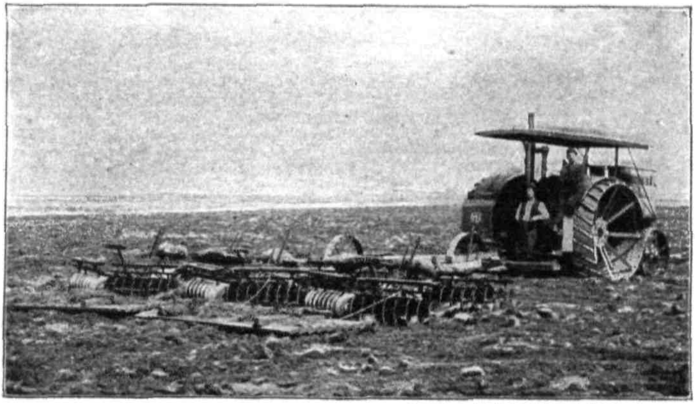


Courtesy of International Harvester Co.

FIG. 80. — Clod masher and disk harrow.

surface, and aërates the soil because of the extensive root system.

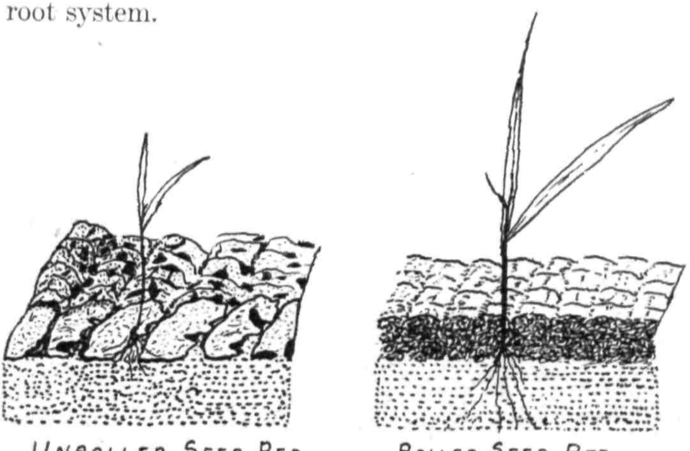
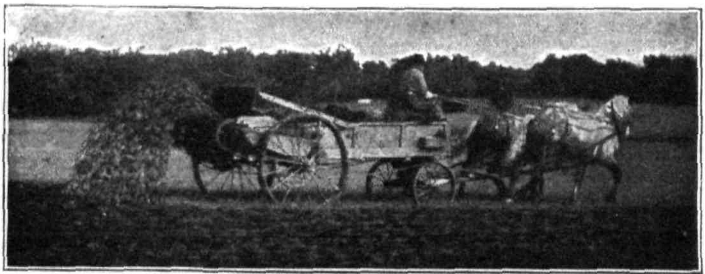


FIG. 81.



Courtesy of International Harvester Co.

FIG. 82a. — Manure spreader.

Use a manure spreader and scatter manure freely over the orchard after it has been plowed. Keep the manure spreader near the barn. Throw the manure

Courtesy of International Harvester Co.

FIG. 82b. — Disking in manure.

into the spreader, and as it needs emptying, take the fertilizer to the field directly. Later, disk in the manure.

Questions

1. Name three ways to start a peach tree.
2. Why is budding or grafting a seedling better than to rear it from the seed?
3. What is the cambium layer? Why must it be considered in grafting and budding?
4. When is the best time to bud and to graft? Why?
5. What is meant by pruning?
6. What happens when a top bud is cut? A side bud?
7. When, how, and why should the orchard be plowed? Cultivated? Rolled? Fertilized?

Home Studies

1. Visit an orchard. Note the trees which have been grafted and budded, the different methods of pruning.
2. Who does the work in the orchards? White labor?
3. Is any method used to stop "bleeding" when a tree is pruned?

Free Bulletins

Peach Growing for Market — Farmers' Bulletin No. 33.

Spraying for Fruit Diseases — Farmers' Bulletin No. 38.

The Apple and How to Grow It — Farmers' Bulletin No. 113.

Practical Suggestions for Fruit Growers — Farmers' Bulletin No. 161.

Pruning — Farmers' Bulletin No. 181.

All Farmers' Bulletins are issued from the United States Department of Agriculture, Washington, D.C.

Note. Start Exercise 1, Chapter XVIII.

CHAPTER XVI

HARVESTING AND MARKETING — PART I

THE harvest always rewards the faithful gardener. Here are some suggestions for the use of your school crop.

Vegetables and flowers taken home. All your life your parents have been doing their best for you. What have you done for them? Here is an opportunity. Take some of your best vegetables and flowers home as a gift.

Sometimes parents wish to buy their vegetables from the school garden. If you sell to your parents, charge the regular price and be sure that your vegetables are worth what you charge.

The market. With a few boards arrange a place for the display of the garden's output. Ask your friends to come to the market for vegetables, or take their orders and deliver your products. Again be sure that your vegetables and flowers are worth the price. Good goods and "square" methods always pay. Some groceryman in your community might be glad to handle your output or rent you a portion of his window.

The school lunch table. In many schools there is a lunch room for the pupils, with a teacher in charge.

A few flowers on the table would add to your enjoyment, and we are sure that fresh, juicy vegetables would.

Fig. 83. — Pop corn at the rate of 100 bushels to the acre from a school garden.

The domestic science class. The school-board, if asked, would be glad to buy vegetables from you for the cooking class.

Give to the poor. A portion of your harvest might

well be given to the needy. Why not have a big Thanksgiving and carry vegetables and flowers to those who need them most? A flower is always welcome.

FIG. 84. — 135 pounds of beets from a city school garden.

Think of your friends, and think of those who have no friends. People who make others happy are most happy.

The school garden luncheon. Near the close of the

term ask your teacher to let your class have a school garden luncheon. Prepare the vegetables and serve them as a class. Invite a few of your best friends to partake of the luncheon. A nice menu card is a radish,

FIG. 85. — A school garden market.

turnip, or a beet done in water colors, afterwards cut out. Cornucopias made of paper and filled with flowers placed at each plate make a pleasing gift to the guests.

Exhibits. During the term ask your teacher to set aside one afternoon for a flower and vegetable show, or have the exhibit on the luncheon day. Invite your friends, and have a flower souvenir for each.

Contests. Contests may be undertaken and prizes given by the state for the best flowers and vegetables. If so, enter them and try your best to win.

Economic plants. Take up the sugar beets; cut off the tops about one inch below the leaves. With graters

Fig. 86. — A school garden exhibit.

shred the roots. Put the fine particles into a clean sack and squeeze out the juice. Stir a little lime into the liquid. A half dozen beets will give enough juice for the experiment.

Ask your teacher how to make carbon dioxide gas. Arrange to pass this gas through the liquid. The gas helps to cleanse the liquid. Carefully pour or siphon

the juice into another dish. Filter out the impurities and boil down to sugar. The sugar will not be white, and there is no simple way of refining or whitening it.

Your teacher may take you to visit a sugar factory. The business man's method is much more difficult than yours. He makes machinery do the work. Without machinery we would have to get along without pure sugar.

Pull the flax up by the roots. Remove the seeds and leaves. Place the flax plants under water from two to six days. If, at the end of the period, the stems break readily and the fiber seems loose, place the plants in the sun to dry. After drying, break the woody matter with a mallet. Make a comb by driving nails through a piece of wood, and comb out the fiber.

Visit a clothing factory if you can. Again the business man depends on machinery.

HARVESTING AND MARKETING — PART II

Two boys, after caring for plots 6×9 feet in a school garden, asked their teacher for more land. Each was given land enough for one row of radish 40 feet long. John prepared his seed bed carefully and sowed 10 cents' worth of seed. Charles hurriedly planted too many seeds, and they cost him 15 cents. John cultivated and thinned his plants on each garden day, while his neighbor wasted time. The radishes in John's row grew vigorously and rapidly and were ready for

the market early. He sold his vegetables himself and received 5 cents for a bunch of eighteen plants, netting him $1.50. A great many of the plants in Charles's row grew to tops crowded by their neighbors, both weeds and other radishes. He often missed a market day, pulling more radishes later than the buyers demanded. Many plants were wasted, and the others were sold, not by Charles himself, but by a boy who charged 20 per cent commission. Charles's radishes, which were small, sold at 24 for 5 cents. Due to lack of care in planting, heedlessness in care of the seedlings, waste in marketing, " commission," etc., he netted but 40 cents. Later Charles did better, for he sold his vegetables at a " free " market established at the school gardens, and so saved most of his commission.

Figure 85 pictures the free market. Each gardener placed his vegetables on sale in a space granted him free. Many sold their own products. Others, like Charles, and still others whose time was more valuable while spent taking care of their plots, paid the " garden commissioner " 5 per cent to manage the sale. At times when the sales were not well advertised, when there was little demand at the gardens, the vegetables were sold to the grocery stores or the city free market at a low rate, since the stores and the market had their profit to make.

John thought hard, worked hard, and received full pay for his labor. His radishes traveled directly from

the small farm to the table. There was no loss due to carelessness, due to waste, and there was no commission to pay a second man — the "middleman." In the first place, Charles lost money by careless seeding and by carelessness in care of his young plants, and in the second place, he paid the middleman a large portion of his profits. Charles's radishes traveled farther than did John's, and the profits were far less.

The best method for the school gardener is to sell the products directly to the "consumer" under ordinary conditions. But, sometimes he may have so much valuable work to do, that it is better for him to "coöperate" with his neighbors to hire a manager for the coöperative market; that is, for him and each of his neighbors to give a little towards paying the salary of the sales manager. Each gardener should help the other.

Ere this you have found that your school garden is very much like a country district or a city. Among other things, you grow products, harvest, and sell them properly and improperly, as does the farmer. Usually the farmer is better fed than the doctor or the lawyer, and better clothed, and he lives more comfortably and happily. Ask your teacher what the average annual income of a doctor, a lawyer, a preacher, a farmer is. With a little more thought and a little more care, however, the farmer could live much better.

There are two ways for a farmer to increase his profits:

(1) by working an acre of land in such a way that more and better products will be grown; and (2) by using more care in handling and selling his crops. The farmers are learning how to make the soil produce larger crops, but they are slow to learn how to market

FIG. 87. — Waste in shipping berries.

them. Just as you are wasteful at times in seeding, neglectful in cultivation and thinning, careless in sending too many vegetables arranged untidily to the market when the demand is low, so is the farmer wasteful. We are told that $708,000,000 worth of manure is wasted each year which might be used as a fertilizer. There are other losses due to ignorance.

Material prepared for the market should be neatly ar-

ranged, clean and uniform. A buyer will always select the bunch of radishes that is clean and neatly tied and which contains roots of equal size. Oftentimes vegetables and fruits travel many miles by teams and railroads. It is quite necessary that care be used in packing (Fig. 87).

Let us follow the travels of a bushel of potatoes; from the farmer to the "consumer." The commission man

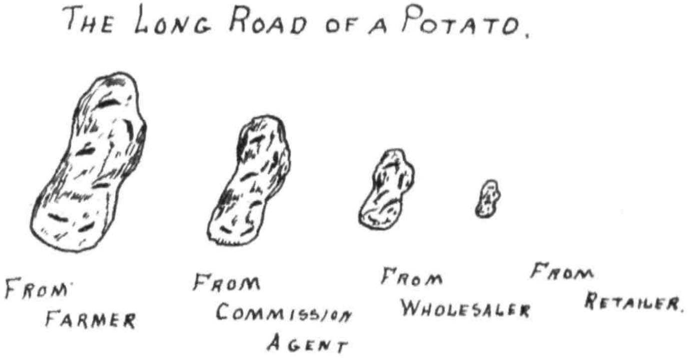


FIG. 88.

pays the farmer, let us say, 60 cents for the potatoes. The buyer sells to the owner of a wholesale house, where products are stored, at 65 cents. The "wholesaler" sells to the groceryman, or "retailer," at 85 cents, and finally the ones who eat the potatoes have to pay \$1.30 for them. The farmer who does the work receives but 60 cents of the \$1.30. The middlemen who live off the farmers' work get most of the amount.

Let us also follow an orange from the tree to your pocket. We are told that it costs an orange grower $1.29 a box to grow and to pack one box of oranges. The cost to the wholesale man who buys from the orchardist is $.828; the freight charges .0789; the cost of icing the box, .07; which equals $.9769. This, with the payment to the grower, makes the box cost $2.27, or each orange cost about 1½ cents, since there are usually 150 oranges to a box. The wholesaler sells the box to the retail merchant, and he in turn markets the box to the people. Both make their profit, and each receives far more for his labor than did the grower. Ordinarily we receive one or two medium-sized oranges for 5 cents. Thus the orange which paid the farmer about 1 cent, increases in price to 3 or 5 cents. Here again the road is too long from the orchard to the home.

The Secretary of Agriculture has found that the farmer gets but one third of the selling price, while the middleman gets two thirds. In the city of Des Moines, as in many other cities, cabbages that the farmers sold for 40 cents a dozen cost the housewives 10 cents a head. Corn paid the grower 9 cents for a dozen ears and was sold by the retail merchant at 20 cents. The mayor of the city decided that if the farmer did not get more, the people should pay less. He opened a free market in the City Hall park. The price of potatoes dropped from $2.50 a bushel to $1.50; eating apples were re-

duced from $2.50 to $1; tomatoes sold for less than half the original price; eggs dropped from 20 to 16 cents a dozen. The average reduction in prices was 40 to 50 cents on a dollar. The result through one helping the other was that both the farmer and the housewife profited.

Thus the greatest loss to the grower lies in his method of selling his crops. The individuals of the garden class of which Charles and John were members, helped each other in hiring a boy to sell their vegetables, so the farmers should coöperate to market their products. This plan has been tried by fruit growers. A good working plan for a Fruit Growers' Association is as follows: —

(1) Divide the state into twenty-five or more local associations; (2) let each association elect one member of a Board of Directors; (3) have the Board of Directors in turn elect a General Manager; (4) assign such duties to the Manager as finding a market for the association's productions, insisting that fruits are properly packed, helping through suggestions to improve the crops, buying supplies, etc

In California 6000 orange and lemon growers have an association. This agency sends fruit all over the world.

Housewives by coöperating may save many dollars in buying household supplies. The following list prepared by a Brooklyn housekeeper shows the saving to a group of women who bought groceries in bulk from the wholesaler: —

	Retailer's Price	Wholesaler's Price
Butter	39 ¢ a pound	30 ¢
Eggs	48 ¢ a dozen	34 ¢
Cabbage	10 ¢ a head	6 ¢
Potatoes	$4.80 a barrel	$2.65
Cauliflower	12 ¢ a head	4 ¢
Lettuce	5 ¢ a head	3 ¢

Canned Goods

Peas	14 ¢ a can	10 ¢
Corn	13 ¢ a can	8 ¢
Tomatoes	14 ¢ a can	9 ¢

Questions

1. Name at least five uses for the garden products.

2. What is meant by commission merchants, retail and wholesale merchants? The middleman, the producer, the consumer? The free market, the coöperative plan?

3. Explain a method of coöperation.

4. How may a farmer increase his profits?

5. Trace the travels of a bushel of potatoes and a box of oranges from the producer to the consumer.

Home Studies

1. Visit an adjoining farm or garden and find out how the products are harvested and marketed.

2. How are they packed for shipment? Is there any loss in marketing through improper packing and shipping?

3. Does the farmer or the producer sell his own products directly to the people, or does he pay a high price to commis-

sion merchants? How much does the commission merchant receive? The producer? How much does marketing through the middleman cost the people who buy?

4. Are there any coöperative associations among the farmers in your neighborhood?

5. What manufacturing establishments are there in your vicinity? Of what value are they to your community?

6. Visit a free market, a bakery, a cannery, a flour mill, a candy factory. Study the manufacturing processes.

FREE BULLETINS

Marketing Farm Produce — Farmers' Bulletin No. 62.

Coöperation in the Handling and Marketing of Fruit — Yearbook of Department of Agriculture, 1910.

CHAPTER XVII

AN AGRICULTURAL CLUB

IN the first lesson you learned that we owe our comfort and our life to the soil. However, the soil, without work added to it, would hardly keep us in comfort. Then we must look to the man who adds work to the soil — the FARMER — for our food, clothing, and shelter. Without the farm and the farmer, our cities and our states could not exist. There are over ninety millions of people to feed in the United States. The farms must do this. It is estimated that in 1950 there will be 200,000,000 people in the United States. The farms must provide for this increased number of people. In furnishing all these people with food and clothing, the farmer will not only gain food and clothing himself, but will live out in the fresh air among his plants and animals.

The United States government wants the farms to be able to feed these 200,000,000 people in 1950. It is trying to get more people to go to the country. It wants more farms started. Surely you will be interested in knowing what is being done to make more farms and better farms.

Experiment stations. At Washington, D. C., is located the United States Experiment Station, and

in each state there is an experiment station (partially supported by the United States government). These institutions, through careful study and through bulletins, help the farmers to control insect pests and plant dis-

FIG. 89. — A flower garden — white and red tulips.

eases. They tell the farmers how to grow better corn, better wheat, etc. If you write to your state experiment office, leaflets will be sent you free which will help in your gardening. (See the list of bulletins in the Appendix.)

High school and normal school agriculture. The high schools and the normal schools are helping to make better farms and better farmers. Some day you may study in a high school or a normal school the best methods for developing a farm.

FIG. 90. — A corn growing club.

Boys' and girls' club. There is a great deal being done to make more farms and better farms. Excellent work is being done by the boys and girls. Thousands of children all over the United States are growing corn, wheat, vegetables, and flowers. The corn clubs of Illinois have increased interest in corn growing. Wherever a boy has grown corn, working under the instructions of the club, the whole community has gained.

In a Southern state one boy decided to join a corn club. His father gave him an acre of stumpy ground. Patiently the boy dug out the stumps. The father tried to discourage his son by telling him that the acre was needed for other purposes, and gave another acre of uncleaned land. This was ready in time. Both planted corn, but the boy worked under the instruction of the club officials. Final account of the harvest gave the father 9 bushels of corn and the boy 84 bushels to the acre.

Possibly the experiment station of your state may have organized clubs. Write and find out. Join, if the opportunity is offered.

Following is a constitution which governs gardening clubs in the state of California: —

CALIFORNIA BOYS' AND GIRLS' JUNIOR GARDENING CLUBS, CONSTITUTION

ARTICLE I

Name of Club

This Club shall be known as the California Junior Gardening Club of School District ...., County of............

ARTICLE II

Regulations

This Club shall be governed by the Constitution of the Junior Gardening Club of California, issued by the Extension Division of the Chico State Normal School, Chico, Calif.

ARTICLE XI

Amendments

These by-laws may be amended by a two-thirds vote of members present at any regular meeting.

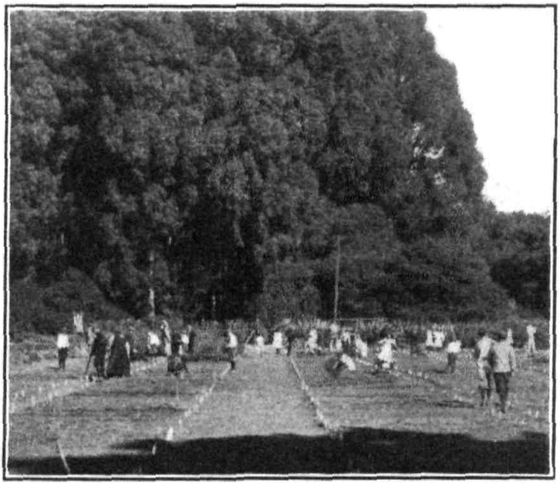


Fig. 91. — The Berkeley Garden City.

The Garden City.

Article XI refers to a Garden City. Several such cities have been organized in California.

The following constitution directs the life in the Garden City: —

ARTICLE I

The name of the garden at .... shall be the "Garden City."

ARTICLE II

The object is the betterment of citizenship among its citizens and the development of body, mind, and morals.

ARTICLE III

Any boy or girl of the ages of six to sixteen may become a citizen by owning and caring for a garden.

ARTICLE IV

The officers shall be: mayor; city council of 4 members; garden commissioner; street commissioner; water commissioner; tool commissioner; city clerk. (City clerk should be appointed on basis of ability and efficiency.)

FIG. 92. — Voting for officers in the Berkeley Garden City.

(*a*) They shall take office September 1st and February 1st of each year.

(*b*) They shall be elected on the Monday preceding the above dates by popular vote.

ARTICLE V

The duties of these officers shall be those usually devolving upon such officers.

ARTICLE VI

Recall: A petition signed by qualified electors equal in number to twenty per cent of the entire vote cast for Mayor at the last preceding general election at which a Mayor was elected, demanding an election of a successor of the officer to be removed, shall be addressed to the Council and presented to the City Clerk.

Grounds of Recall: Reasons for the recall of an officer shall be stated in the call for the new election.

The officer or officers for recall may become candidates at the new election.

ARTICLE VII

Gardeners shall work at least two hours a week. During the season each shall work ten hours for the public good.

ARTICLE VIII

For lease of the individual plot and for other privileges, each gardener shall give ...... per cent of the output of his garden.

ARTICLE IX

The "Garden City Bank" shall handle all financial activities connected with the "city."

ARTICLE X

The officers of the "Garden City Bank" shall be appointed by the Garden Director.

ARTICLE XI

A "Garden City" market shall be established at which the output of the gardens may be placed on sale.

ARTICLE XII

The City Council shall meet as requested by the Garden Director or the Mayor, at which meeting all officers shall report.

ARTICLE XIII

Amendments can be made to this constitution upon a week's notice with approval of the Garden Director.

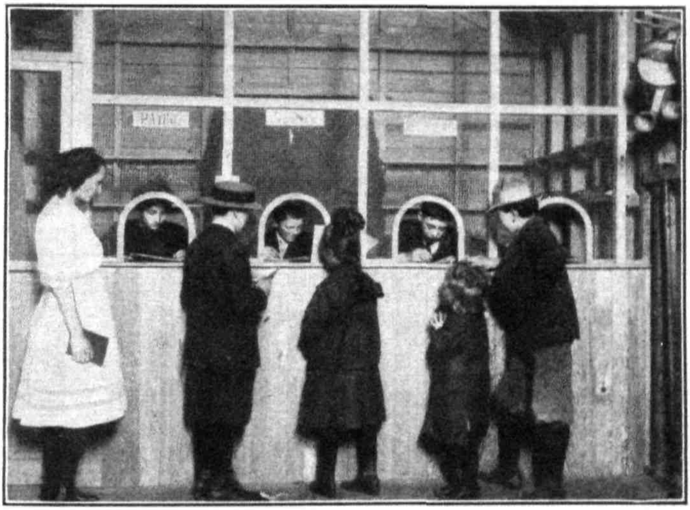


FIG. 93. — The Garden City bank.

THE BERKELEY GARDEN CITY

In return for the use of three acres of land, tools, water, and seeds, the Berkeley superintendent of schools allowed the fifth and sixth grade children of one school to come to the plot set aside for gardening on the

campus of the University of California. The boys and girls, 120 in number, came during school hours. Each boy and girl was given an individual plot 6 × 9 feet. As his or her ambition grew, new land was given. Later the gardens were opened on Saturday mornings to any of the children in Berkeley 6 to 16 years of age. Two

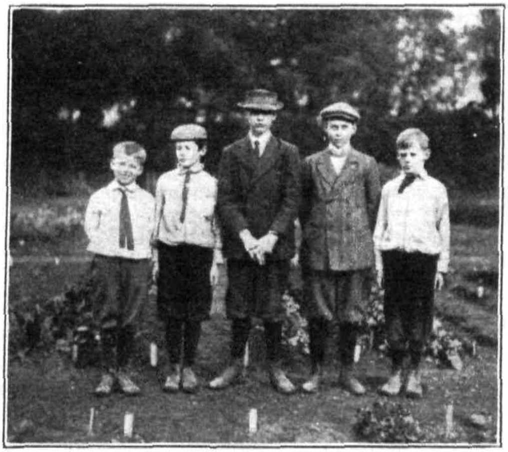


FIG. 94. — Garden City officials.

hundred citizens reported regularly twice a week. Citizens of the Garden City they were, for a city organization was formed governed by the charter or constitution which is given in this chapter. Officers (see constitution) were elected by the Australian ballot system (Fig. 92).

As soon as the gardens began to produce, a market

was established. The products were placed on sale. The children voted 50 per cent of the sales of the City

FIG. 95. — The Garden City bulletin board.

towards paying expenses of a building, etc. Each Saturday morning the parents and their friends came to buy at the Garden City market. A need was felt

at once for a banking institution to handle the money of the City and the citizens. A bank was established (Fig. 93). The officers were selected by the garden supervisor. All money passed through the bank. Citizens who opened accounts with the bank received individual deposit books, checks, etc.

Portions of the new city building were set aside for the addition of work benches and a small printing establishment. Thus the children caring little for gardening did the carpenter work.

In all of the City's activities the boys and girls were aided by the University students.

Ask your teacher, or the mayor of your city, if your home is in a city, to organize such an industrial playground. You will enjoy such school work.

THE DUTIES OF THE GARDEN CITY OFFICERS

Mayor —

(1) to preside at and to call all meetings of the council.

(2) to act with the council in all matters referred to him.

(3) to have general supervision, with the garden director, and the teachers, of the City in all those things which pertain to its welfare.

Commissioner of Tools —

(1) to have general supervision of tools; namely —

(*a*) to see that all tools are handled properly — tools not in use should be placed with prongs or blades down; a citizen may have but one tool when others have none, and if this tool is not in use, it may be taken with permission; tools broken should be fixed or replaced by the one responsible for the break.

(*b*) to see that all tools are dry cleaned and placed neatly in the tool house; and to perform such other duties as are necessary for the care of the tools.

Commissioner of gardens —

(1) to take the roll of citizens on each garden day.

(2) to see that the seed beds are properly made —

(*a*) the bed raised slightly.

(*b*) the center made higher than the edges.

(*c*) the edges made flush and even with the stakes.

(*d*) the rows kept straight and the proper distance apart with labels telling kind of seed planted and when; and to perform such other duties as pertain to the making of a good garden.

(3) to have charge of the Garden City market.

(4) to apportion seeds.

Commissioner of Water —

(1) to supervise the irrigation of the gardens —

(*a*) the trench method for individual gardens and the flooding system alone should be used.

(2) to see that no hydrants are left running.

(3) to see that water is not allowed to run on the paths; and to perform such other duties as pertain to the use of water.

Commissioner of Paths —

(1) to see that all paths are graded properly.

(2) to see that paths are kept free from refuse matter of any kind.

The officers in all cases shall do their best to fulfill their duties. In cases of disobedience to the laws of the City, a report shall be made to the mayor. If disobedience then continues, the report shall be carried to the garden director or a teacher.

In no case must an officer, in trying to fulfill his duty, place his hands upon a citizen unless permission has been given by one in authority.

Each officer should be "square" to his responsibility.

If any officer cannot report regularly and perform his duties, he should appoint an assistant and make the appointment known to the mayor.

The council shall with the garden director take such action as is necessary in all matters pertaining to the welfare of the citizens.

The Duties of Citizens

1. To observe the laws of the Garden City Constitution.
2. To support and to obey the officers elected.
3. To report to the mayor any officer delinquent in his duties or who is overbearing in the enforcement of his work.

Home Studies

1. How are your state, your county, your town or city, governed?
2. Is your community modern in streets, lights, etc.?
3. Are the people in your vicinity slow to vote additional money for schools, better roads, and other improvements? Why?
4. Are you living in a hygienic community? Do house-flies abound? How is waste disposed of? Is there any control of the milk supply? Is there much sickness? If so, why?
5. Visit a dairy, a creamery, a lighting plant, a water supply, a bank, a newspaper establishment.
6. Is there any history in this chapter? What is "history"?

Note. Prepare the material for Exercises 3, 4, and 5, Chapter XVIII. Start Exercises 1, 6, and 7, Chapter XIX.

REVIEW QUESTIONS ON CHAPTERS VI TO XVII INCLUSIVE

1. Explain the trench, the flooding, the sprinkling methods of irrigation. Which is the best method under ordinary garden conditions? Why?
2. What is the main business of a plant? How has the farmer taken advantage of this fact?
3. What effect has transplanting on a seedling?
4. What is gained by cultivation?
5. What may be done to prevent hardpan?
6. Plan a flower scheme for a window box.
7. Tell how your home, your schoolhouse, your city, might be made more beautiful.
8. Give a few rules for making paths, a lawn, flower beds, for placing shrubs and trees.
9. What points should be considered in selecting an ideal home, school grounds, and a farm?
10. How would you start a rosebush, a carnation, a hyacinth, a grapevine, a potato plant, a peach tree?
11. Tell how to bud and graft a fruit tree.
12. Explain a method of coöperative marketing. What is gained by coöperation?
13. Why does the farmer get so little for his labor?
14. Name all the farm wastes that you can.

CHAPTER XVIII

ROOTS[1]

Exercises

1. Suspend seeds in a tumbler with netting. When the roots are well started, snip them off with scissors. (2 wk.)

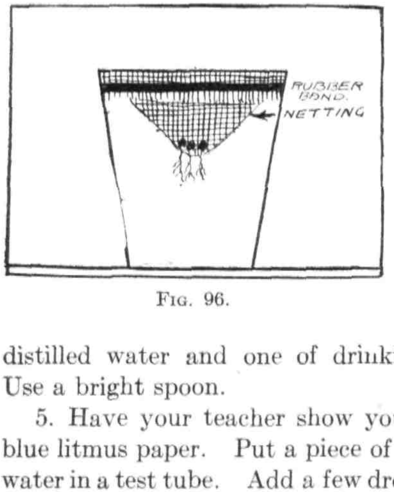


Fig. 96.

2. Observe the experiments set up in Chapter VI, or repeat them.

3. Stir a pinch of salt into a tumbler half full of water. After the salt has disappeared, heat a teaspoonful of the solution slowly, and observe the results.

4. Evaporate in a similar way a teaspoonful of distilled water and one of drinking water. Note results. Use a bright spoon.

5. Have your teacher show you the effect of an acid on blue litmus paper. Put a piece of marble or chalk in a little water in a test tube. Add a few drops of acid. Note results.

6. Drop a piece of blue litmus paper into tap or well water. Note results after a few hours.

[1] To the Teacher. If the gardens are well under way, time should be taken to make a classroom study of Chapters XVIII to XXIV inclusive.

The work of roots. The common uses of roots are to hold the plants in place, to furnish soil water and food, and sometimes to hold stored-up food until it is needed to start and to feed a new plant.

Kinds of roots. Fibrous roots may be seen by pulling up an oat or barley plant. They are long and slen-

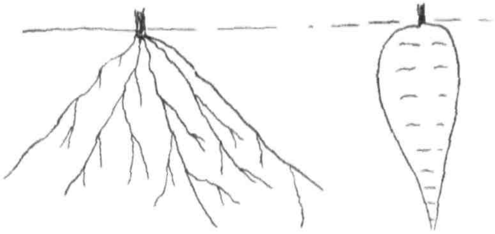


FIG. 97.

der in nature. Fleshy roots are those which have a thick, stout body. When such a root tapers downward to a point, it is called a tap root. A beet, a carrot, have tap roots.

The root furnishes soil water and soil food. Exercise 4 in Chapter IV showed that plants need food.

In Exercise 3, the particles of salt become so very small that they slipped in between the particles of water and disappeared something as a handful of peas thrown into a barrel of apples would disappear. When salt or other substance disappears in a liquid, it is said to be in solution. The heat drove the water off, leaving the salt. There was nothing in solution in the dis-

tilled water, while the drinking water contained some substance. You have learned that plants will not live in distilled water, but will grow in tap water. This substance which was left in the spoon must have been some plant food. Plants can only use food that is in solution. They need lime, nitrogen, phosphorus, and potash particularly, just as you need bread and meat. All of these must be dissolved in water (in solution) before the plant can use them.

An acid at work with water and chalk. An acid, chalk, and water do not mingle well. A great commotion is set up. The particles bump against each other until the chalk disappears and the dish gets warm. Strike a nail several times with a hammer and the nail becomes warm; so it is with these particles. They warm the tube. The singing noise was made by thousands of little bubbles of gas bursting at the top. The singing of the teakettle is due to the same exploding bubbles. Blow a paper bag full of air, close the top, and break the bag. Think of thousands of bags breaking continuously and you have a singing noise.

Water usually contains an acid. Exercise 6 shows that water which comes directly from the soil usually holds an acid. Here is another use for water, to put in solution minerals which plants need. Exercise 5 shows that acids put many minerals in solution so that plants may use them.

QUESTIONS

1. What is the function of roots?
2. Name and describe the kinds of roots.
3. What is meant by a substance being in solution?
4. Does distilled water contain plant food? Why not? Does tap water contain plant food? Why?
5. In what shape must plant food be for the use of the plant?
6. What food do plants need?
7. What is an acid?
8. Why does the dish used in Exercise 5 get warm? What causes the singing noise?
9. What helps to put plant food in solution?

NOTE. Start Experiments 3 and 4 in Chapter XIX. Get material ready for the other exercises.

CHAPTER XIX

ROOTS *(continued)*

Exercises

1. Fold a piece of blue litmus paper and insert in a funnel (Fig. 98). Fill the funnel with clean sand or cotton. Place a few wheat kernels next to the litmus paper. Keep moist with distilled water (why distilled)? (1 wk.)

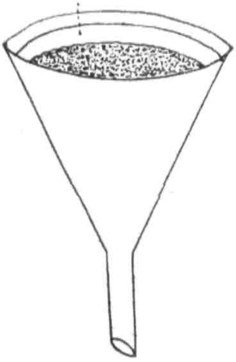


Fig. 98.

2. Examine the experiments set up in Chapter IV to show the food needs of plants.

3. Hollow out three radish or carrot roots. Place sugar in two of the openings. Stand one root in water next to the one containing no sugar. Place the other root in an empty dish. Note results in 24 hours.

4. Grow a few radish seeds on the surface of a pile of moist sand. Observe the fine root hairs. Notice how the sand particles cling as a plant is pulled from the sand. (1 wk.)

5. Pull up by the roots a clover or alfalfa plant. Note the beadlike swellings on the roots. What causes them (Fig. 100)?

6. Knock the bottom out of a chalk box. Tack wire

netting over the opening. Fill the box half full of sawdust, and plant seeds. Keep the sawdust moist. Arrange the

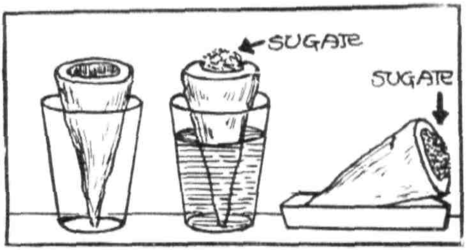


Fig. 99.

box as shown in Fig. 19, Chapter VI. (2 wk.) (Repeated from Chapter VI.)

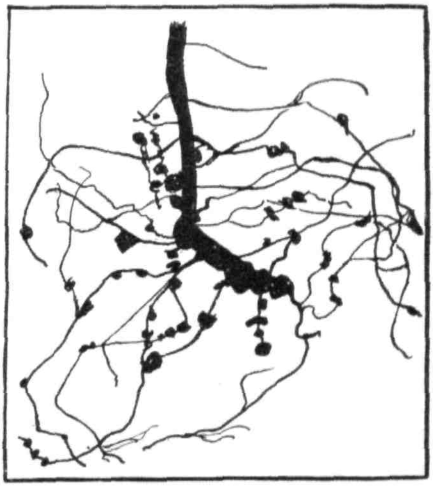


Fig. 100.

7. Grow corn or peas in two boxes. Sprinkle one and irrigate the other with trenches. When the plants are well up, pull some from each box and compare the roots. Note the surface roots of the plants that were sprinkled. (2 wk.) (Repeated from Chapter VI.)

8. Weigh a fresh plant (a corn stalk). Heat it thoroughly until all the water is driven out, and weigh again. Burn the

plant and weigh the ashes. Estimate the amount of water that was in the plant. What per cent of its weight is ashes?

Roots secrete an acid. If you empty the sand from the funnel set up in Exercise 1, and examine the litmus paper, you will find a red mark wherever a root touched the paper. This red line shows the presence of an acid, and it must have come from the root. Thus the roots make an acid which helps to put mineral, or soil food, in solution.

Plant foods may be added to soils. Nitrogen may be added to your garden by working in fresh manure. Sometimes clover is grown and then plowed under when the farmer wishes to add nitrogen to the soil. Phosphorus is best added by applying a prepared fertilizer; ground-up bone contains phosphorus. Potash may be furnished by working in wood ashes. Nitrogen is conducive to early, rapid growth. Potash hardens plant growth and gives added strength to the fruit and to the flower. Fine color and health are given with phosphorus. Lime added to the soil 500 to 1000 pounds to the acre loosens soil food so that plants do much better. Ask your teacher to show you samples of nitrate of soda, potash, and acid phosphate.

Products such as wheat, oats, and fruit take much nitrogen from the soil (Fig. 101). Plants cannot live without nitrogen. If wheat were grown year after year in the same soil, soon the nitrogen would be used up. Clover and similar plants, through the assistance of bacteria, get most of their nitrogen from the air.

The beadlike swellings on the roots of clover and alfalfa contain millions of bacteria. Bacteria are very tiny plants which are found everywhere. One kind of bacteria locates on the roots, takes nitrogen from the air, and fixes it in the soil. Thus nitrogen is stored for the use of other plants. The wheat takes nitrogen from

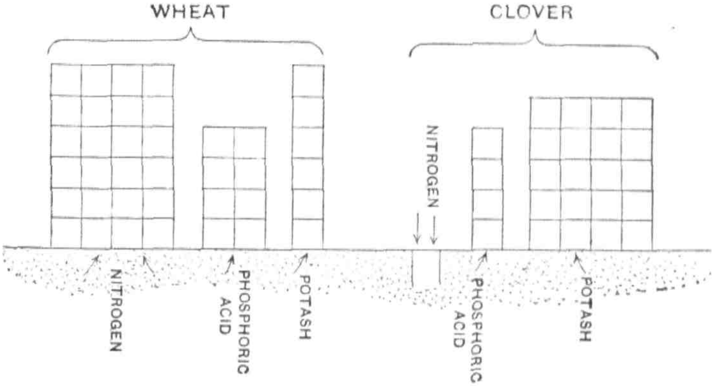


FIG. 101.

the soil. The clover restores nitrogen. By growing wheat three or four years and then planting clover, the land is kept fertile. This changing of plants is called "rotation of crops." Radishes and lettuce need different food from corn, so in your gardens they should be rotated.

Results due to rotation of crops.

Wheat after wheat, 15.66 bu. to the acre.

Wheat after Canadian field peas (turned under), 33.666 bu.

Wheat after horse beans (turned under), 35.33 bu.
Wheat after rye (turned under), 51.33 bu.

Harmful bacteria. There are millions of bacteria that do good, and millions that do harm. Typhoid fever, diphtheria, and many other diseases are caused by bacteria. Bacteria cause milk to sour and fruit to decay. If in cultivating, or in any other way, the roots of a plant are injured, bacteria may cause the roots to rot and the plant to die.

Bacteria do plants more good than harm. The soil is full of bacteria. They need air, as do other plants. Now you have learned another reason for porous soil. You have learned another reason for not overirrigating, since too much water drives the air out of the soil.

Gravity, moisture, and food tell which way the root is to grow. A ball thrown into the air falls. The earth draws it back. This " pull " of the earth is called gravity. Gravity draws roots downward. The roots in Exercise 6 came through the netting because of the pull of gravity. Many of them turned back because of the moist sawdust. Water attracts roots. *Roots grow in the direction of some continuous force.*

Sprinkling causes roots to grow near the surface. Exercise 7 teaches that frequent surface irrigation causes shallow roots. Plants with roots set shallow cannot stand a period of dry weather. Subirrigation and trench irrigation are best, because the water is beneath the roots, which grow deep in the ground.

The root hairs pump water and food into the main root. The root hairs which cling to the sand particles (Exercise 4), are tubelike. They slip between the particles of soil and take up the soil food that is in solution. Without the small root hairs a main root would have to be a great many times as large as otherwise.

Water was drawn through the walnut shells containing sugar (Chapter III, Exercise 5). The root containing sugar (Exercise 3) was the only one full of moisture. Evidently the sugar caused the water to enter the shell and the root.

Roots furnish about 3 per cent of the plant's structure. You have learned (Experiment 8), as others have learned, that only about 3 per cent of a plant's substance comes from the soil. Nearly 97 per cent comes from the air.

Questions

1. How may nitrogen, phosphorus, and potash be added to soil?
2. What plants take nitrogen from the soil? What plants add nitrogen?
3. What are bacteria?
4. Of what use are bacteria on clover roots?
5. What is meant by rotation of crops?
6. In what way are some bacteria harmful?
7. What causes roots to grow in certain directions?
8. What effect has sprinkling on root growth?
9. Which is the stronger plant, one with shallow roots or one with roots set deep?

10. Where should the water be to make strong plants?

11. Of what use are root hairs to a plant?

12. What per cent of a plant's structure comes from the soil? The air?

Home Studies

1. What is meant by commercial fertilizers?

2. Do any of the farmers in your neighborhood use such fertilizers? If so, how are they used?

3. Find out if crop rotation is practiced in your vicinity. If so, what crops are rotated?

4. Ask some one what is meant by "soil inoculation." Has it ever been tried in your locality?

Free Bulletins

Beneficial Bacteria for Leguminous Crops. — Farmers' Bulletin No. 214.

Note. Start Exercise 1, Chapter XX; Exercise 2, Chapter XXII; Exercises 1, 2, 3, Chapter XXV; and obtain the material for Exercise 3 and the other exercises.

CHAPTER XX

THE STEM

EXERCISES

1. Place stems of calla lilies, celery, and sweetpeas with white flowers attached in colored water. Several hours later examine the flowers. Note the red lines, if red coloring matter is used. Cut the lily stems lengthwise. Trace the colored liquid through the stems.

2. Cut a lily or corn stem and a rose stem in two. Compare the two stems (Fig. 102).

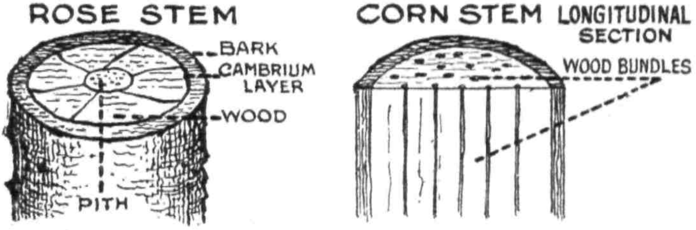


FIG. 102.

3. Examine as many stems as you can find and group them into two classes, as represented by the rose and the corn stems.

4. Find stems that are erect, creeping, prostrate, climbing, and twining.

5. Make a cross section of a tree more than a year old. Count the number of rings found.

6. Make a collection of different kinds of stems.

The work of the stem. When a piece of meat is taken into your stomach, it is put in solution and carried by the blood to all parts of your body to make flesh. All parts of a plant need food to make them grow. Soil food in solution is taken in by the roots. This watery material, or sap, carries the food through the stem to the leaves as it carried the red ink in Exercise 1. Food in solution also comes down from the leaves to the roots, as you will learn. The stem acts as a piping system as well as a support conveying food in solution (Chapter XXI, Fig. 106).

You have learned that the main business of a plant is to form more plants. Plants that are crowded do not grow well. Many die for lack of water and food. If a dandelion plant has a long stem, the seeds will be lifted high so that the wind will scatter the seeds widely. There will be little danger that the new plants will crowd each other. However, if another dandelion is not strong and does not have a long stem, the seeds may not travel far. The new plants will be crowded, and many may die. Another use for the stem is to lift the flowers, the leaves, and later the seeds, high in the air.

Many plants, such as the potato, store up food in the stem for its own use. This food is often taken by animals.

How stems grow. Animals grow all over, but stems do not. One kind of stem, like the rose, grows mainly near the outside. When trees grow, each year a ring

of new wood is formed between the old wood and the bark. These rings are easily seen (Exercise 5). A tree with five rings is usually five years old.

Stems such as the lily and the corn grow mainly on the inside. New bundles of wood (Fig. 102) are continually forming. Stems that grow on the inside are usually without many branches; for example, corn, lilies, and palms.

Stems grow in different directions. Stems may be erect, corn; prostrate and running, wire grass; climbing, peas and grapevine; twining, morning-glory.

Questions

1. What is the work of stems?
2. What does a plant gain from a long stem?
3. In what two ways do stems grow?
4. Describe the difference in structure between a corn stem and a rose stem. Make a cross-section drawing of each.
5. How can you tell the age of a tree?
6. Name different kinds of stems as to their direction of growth.

Note. Start Exercises 2, 3, 6, 7, 8, 9, 11, and 12, Chapter XXI, and get material ready for the other exercises.

CHAPTER XXI

THE LEAVES[1]

Exercises

1. Buy 5 cents' worth of iodine crystals from the druggist. Dissolve a few of the crystals in alcohol. Add a drop of the solution to a little cooking starch. Cut in two a kernel of corn which has been soaked, and treat in a similar way. After a few minutes note the blue color.

2. Place in a cup a geranium leaf which has been exposed to the sun all day. Cover with wood alcohol. In a few hours the green matter will dissolve from the leaf. This green matter which comes from the leaf is called chlorophyll. Test this leaf with iodine. Note the color changes.

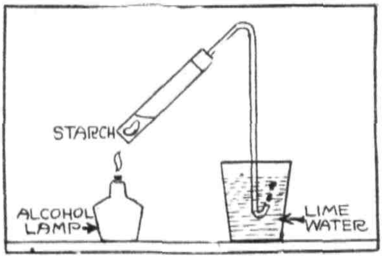


Fig. 103.

3. Ask your teacher to make carbon dioxide and to test it with limewater. Ask her to set up the apparatus as shown in Fig. 103, or do both yourself. As the starch becomes warm, note the moisture on the sides of the test tube, and the change in the lime water as the bubbles rise.

[1] To Teacher. If you find the two chapters on leaves too technical, omit them.

4. Blow through a tube into a dish of limewater and note results.

5. Lower a burning candle into a bottle. What happens? Pour a little limewater into the bottle and shake. Note results.

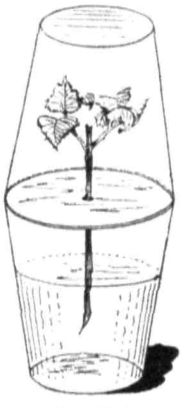


FIG. 104.

6. Let a dish of limewater remain over night exposed to the air. What happens?

7. Arrange tumblers and a geranium cutting as shown in Fig. 104. Note the drops of water on the inverted tumbler.

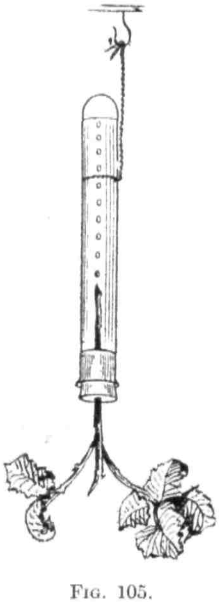


FIG. 105.

8. Place a rolled leaf in a test tube. Plug the tube with cotton. What gathers on the sides of the tube?

9. Obtain two geranium leaves. Put vaseline on the upper side of one leaf, and on the under side of the other. Roll them both and place in two test tubes. Close the tubes. Note results.

10. Burn a match. The black matter which is left is carbon.

11. Set up apparatus as shown in Fig. 105. Use laurel or magnolia branches. Fill the tube full of boiled water, make air-tight, and place in the sun. Note the stream of bubbles coming from the end of the stem.

12. Place a geranium plant in the dark for several days. Pull off a leaf. Use alcohol and dissolve out the chlorophyll.

Test for starch. Obtain a variegated geranium leaf and test for starch. Note the lack of starch in the spots which are not green.

13. Try dissolving starch and sugar in water. What are the results?

The work of leaves. A flattened bicycle tire becomes rigid when pumped full of air. A wilted plant becomes rigid when the roots and leaves fill or pump it full of water. During the filling or pumping process, food is taken into the plant in solution. There is but little food in solution in comparison to the amount of water. The water escapes from the leaves (Exercises 7 and 8), leaving the mineral food which was in solution behind, just as the water evaporated from the spoon, leaving the salt behind (Exercise 3, Chapter XVIII).

Soil food is very much diluted; that is, as stated before, there is but little food in comparison to the amount of water. This evaporation process, called transpiration, takes place through little openings, "stomata," usually in the under side of the leaves (Exercise 9). A large oak tree may transpire 150 gallons per day during the summer. Ordinarily, for each ounce of dry plant made, from fifteen to twenty-five pounds of water pass through the plant.

Method to prevent transpiration. Transpiration in a measure is controlled by the plant through its leaves. Tender new blades of grass are rolled to prevent evaporation. Many leaves have a hairy or a waxy covering.

If such leaves are dipped in water, it runs off at once. Thick covering and fleshy leaves prevent moisture from escaping. There are other methods used by leaves to hold their water; look for them as you find time.

The greater portion of a plant is carbon. This substance is built into plant tissue by the leaves, and they take it from the air.

Many plants, such as cabbage and lettuce, store food in their leaves.

Plants need proteids and carbohydrates. Such foods as bread and potatoes are made mostly of starch, and they are called carbohydrates. They contain large amounts of carbon and water in comparison to other substances. Meats and many other similar foods are said to be proteids. Besides carbon, they contain nitrogen, sulphur, etc. You could not live without carbohydrates and proteids, nor can a plant.

Test for starch. Iodine turns starch blue. Corn kernels and leaves contain starch (Exercises 1 and 2). Let us note how it is made by the leaves.

Composition of starch. Starch is made of carbon dioxide and water. The milky limewater (Exercise 3) showed that carbon dioxide came from the starch, and the water on the sides of the tube came from the same place.

The plant takes in carbon dioxide and water. Exercise 11 taught you that air enters the leaves of a plant and in the process takes in carbon dioxide, for the air

contains this gas (Exercise 6). You know that there is water in leaves from Exercises 7 and 8. If starch is made of water and carbon dioxide, and starch is found

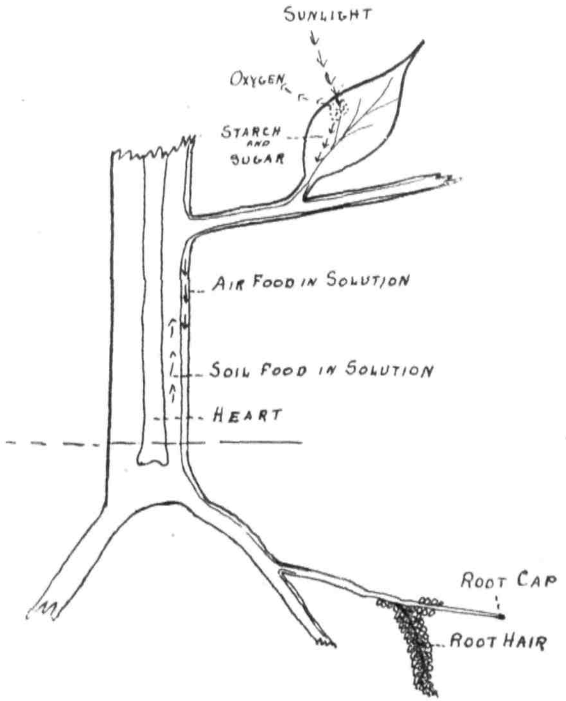


FIG. 106.

in a leaf which has been exposed to sunlight, the leaf must make starch from the water and carbon dioxide which it contains. The water comes by way of the roots.

Starch digestion. Water will not put starch in solution, but it will sugar. Therefore, before starch can be used by the plant, it must be changed to sugar. It then goes into solution and is carried by the sap throughout the plant.

Use of chlorophyll. The green color of leaves is due to tiny green particles. Without them starch cannot be made (Exercise 12). Sunshine is necessary to start the chlorophyll to work. Think of the chlorophyll bodies as a tiny steam engine. The sunshine starts the little engine to work; it puts carbon dioxide from the air with the water in the leaf and makes starch. This is then changed to sugar in a mysterious way and used by the plant.

QUESTIONS

1. What is the work of leaves?
2. What keeps a plant rigid?
3. What is transpiration?
4. How much water must a plant handle to get enough food to make a pound of dry plant tissue?
5. Plants are made mostly of what?
6. Name two kinds of foods. Give examples of each.
7. What is the test for starch? Of what is it composed?
8. Where is starch made in the plant? How do you know?
9. In what form must starch be in order to be used?
10. What is chlorophyll, and what is its use?

NOTE. Start Exercise 3, Chapter XXII, and get the material ready for Exercise 1.

CHAPTER XXII

THE LEAVES (*continued*)

Exercises

1. Ask your teacher to make two or three bottles of oxygen. Can you see it? Test the gas with a burning splinter.

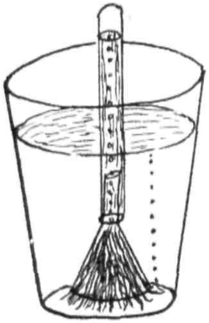


Fig. 107.

2. Invert a funnel over some water plant and complete the experiment by arranging the apparatus as shown in Fig. 107. Set the apparatus in the sunshine. When the gas rises in the test tube and drives out the water, test with a burning coal. What is the gas? (3 wk.)

3. Arrange apparatus as shown in Fig. 108. Invert both jars separately over the burning candle. It soon goes out, due to the carbon dioxide. Insert a leaf beneath one jar after withdrawing the candle without lifting the jar from the water. Twenty-four hours later carefully raise the jars and slip the lighted candle under each separately. Note results.

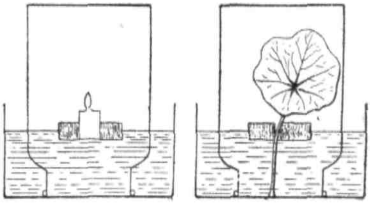


Fig. 108.

Proteid digestion. The food made by the leaves mixes with the food taken in by the roots, and proteids

are made which with carbohydrates build up the body of the plant. All animals, we have learned, need carbohydrates and proteids. They get them by eating plants and other animal matter which contain these substances.

Leaves take in carbon dioxide and throw off oxygen. Leaves absorb carbon dioxide (Exercise 3). They break it up, store away the carbon, keep some of the oxygen, and throw out the rest (Exercises 2 and 3).

The relation of plants to animals. Carbon dioxide first came from the great volcanoes. Then came the plants which absorbed this gas, broke it up, and let loose the oxygen. Animals cannot live without oxygen, so animal life was and is entirely dependent upon plants. Plants take in carbon dioxide and throw off oxygen, but animals, though they too breathe, do not. Animals take in oxygen and throw off carbon dioxide. Thus one depends upon the other.

Animals live at the bottom of a sea of air and at the surface of the great ball, the earth. In each are the substances which animals need for food. However, without plant life they are like a man adrift in the ocean dying of thirst, with water all around, for without the plant to take substances from the air and the soil to make them into food, animals could not live.

Without sunshine the chlorophyll is not active, and the plant becomes more like an animal. It throws off a small amount of carbon dioxide. A few plants in

a sleeping room give off about as much of this gas as a family of mice.

Often a schoolroom or a theater becomes unpleasant, due to the carbon dioxide and other excretions that are thrown off by the people in them. You should keep your sleeping room windows wide open, summer and winter, so that pure *moving* air may be present.

The carbon circle. A tree absorbs carbon dioxide, stores the carbon, and liberates oxygen. The tree catches on fire and burns. The carbon returns to the atmosphere and may be absorbed again by an adjoining tree.

Questions

1. Explain proteid digestion in plants.
2. What is the use of proteids?
3. Name the sources of starch and proteids for animals.
4. What is the relation of plants to animals?
5. Why should not many plants be kept in a sick room at night? Would they be helpful during the daytime?
6. What is the danger of a crowded room?
7. Which is the more harmful to health, an electric light or a gas light? Why?
8. What is meant by the carbon circle?

Note. Get the material ready for the exercises of the next chapter.

REVIEW QUESTIONS ON CHAPTERS XVIII TO XXII INCLUSIVE

1. Is your community modern in streets, lights, etc.?
2. Are the people in your vicinity slow to vote money for schools, better roads, and other improvements? Why?

3. Are you living in a hygienic community?

4. What is the work being done in your community?

5. What work is done by roots, by stems?

6. How may nitrogen, phosphorus, and potash be added to soil?

7. What is meant by rotation of crops? What is gained by crop rotation?

8. Of what use to man are bacteria on clover roots?

9. What is meant by soil inoculation?

10. What does a flower gain by having a long stem?

11. What is the main work of leaves?

12. What is the relation of plants to animals?

13. What is meant by the carbon circle?

14. Which is the more harmful to health, an electric light or a gas light? Why?

CHAPTER XXIII

THE FLOWER — ITS PARTS

Exercises

1. Get a blossom from a geranium, a morning-glory, a cherry tree, or some similar plant. Notice the highly colored, most striking part of the flower. This is the corolla. Count the number of corolla leaves, or petals.

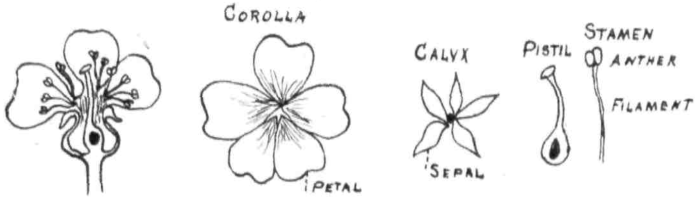


Fig. 109.

2. Carefully pull away the petals. The green cup is the calyx. Count the number of calyx leaves, or sepals.

3. Remove the sepals. The pistil and stamens are left.

4. Carefully tear off the stamens. Count them. Note the yellow grains, the pollen. Make a drawing of a stamen. Also draw the pistil which is left. Observe the sticky material on the stigma of the pistil.

5. With a sharp knife carefully cut the pistil in two lengthwise, and draw what is seen.

6. Examine a blossom from which the petals have fallen. Find the fruit. Do all blossoms contain fruit? Examine an ear of corn. Are all the kernels the same size?

7. Learn to distinguish the parts of a flower in all the common ones you meet.

THE PARTS OF A FLOWER AND THEIR USES

The use of a flower. In the summer the ground is covered with a mass of weeds and flowers. These plants produce seeds and seemingly disappear, only to awaken with the spring rains. Thousands of plants die just as soon as new seeds have been formed. Thus we learn that the main business of a plant is to form seeds and therefore make new plants. If a plant is kept from going to seed, it will live much longer, usually until seeds are formed. The farmer cuts back his alfalfa just before it goes to seed. The plant in its effort to make new plants furnishes the grower of alfalfa with many crops of hay.

Parts of a flower. The corolla. The most showy part of blossoms is usually the corolla (Fig. 109). It is the inner set of leaves. Later you will learn that bright colors of the corolla are to help to attract bees and other insects. The petals make up the corolla. Often in learning the name of a flower it is necessary to know the number of the petals.

The calyx. The calyx is usually green. It is the outer set of leaves (Fig. 109). The leaves are called sepals. The calyx folds over and protects the young blossom before it unfolds, and it supports the blossom as it opens. Calyx is a Latin name for flower cup.

The stamens. A stamen is composed of the anther and the filament. The anther is the swollen tip which contains the pollen. The long, slender stem is the filament.

The pistil. The pistil is the central portion in which seeds are formed. The enlarged lower part is the ovary, tapering into the style, and on top of the style is the stigma. Within the ovary are the ovules which are to become the new seeds (Fig. 111, Chapter XXIV).

The pistils and the stamens are the essential parts of a flower; that is, without them new plants could not be made. A blossom containing these necessary parts is said to be complete. Corn, melons, and flowers of many plants are incomplete; that is, they may contain stamens only, or pistils. One melon blossom may contain the pistil and another the stamens. The two kinds of flowers may be on the same plant, as in the corn, or on different plants. The plumelike tassel of the corn contains flowers usually with stamens only, while the young ears bear the pistils which are the "silk."

The fruit. The fruit is the ripened ovary. It may be a nut, a grain, a pod, and so on. The fruit of the pea is the pod; the peas are the grown ovules, or seeds.

Food is stored in the fruit. It is attractive to birds and other animals. The bird may eat an olive and drop the seed in a distant spot. Thus plants may be widely spread, and this is a good thing for the plants. Do you know why?

The seeds. The seeds are produced by the ovary and are the ripened ovules. You have learned that within the seed is an embryo plant and its food.

Questions

1. What is the main use of flowers?
2. Name the parts of a complete flower and give their uses.
3. What are the essential parts of a flower?
4. What are complete and incomplete flowers?
5. Name plants that have complete blossoms; incomplete blossoms.
6. Name a "staminate" plant; a "pistillate" plant.
7. What is the fruit and its use?

Home Studies

1. Make a list of plants having complete and incomplete blossoms that are found in your neighborhood.
2. Find out what simple and compound flowers are, and make a list of each.
3. Examine all the flowers you can. Are the number of stamens, sepals, and petals alike in the same kind of flower? In different kinds? Are the pistils all alike? Notice the arrangement of the stamens and pistils in each flower. Are the anthers above the stigma or below?
4. Examine many ears of corn. Are the kernels of equal size? Open pea pods. Are the peas of equal size? See Chapter III, Fig. 14.
5. Note the great number of seeds each plant has. Why is this?

Note. Read the exercises of the next chapter and get the material ready.

CHAPTER XXIV

THE FLOWER (*continued*)

Exercises

Fig. 110.

1. Select a bud just ready to open on some plant — a white sweetpea blossom. Carefully remove the corolla and the anthers. Tie a greased paper bag around the bud to keep insects away (Fig. 110). Several days later add a little pollen taken from a pink sweetpea blossom to the inclosed stigma. Replace the bag. When the seeds are ripe, gather and label them. Plant the following year and note the colors of the flowers.

2. Watch different colored flowers for several minutes and note the visit of insects, particularly bees. Note where the bees stand when visiting a flower. Is there a little platform? How are the pistil and stamens arranged in these plants? Are they curved so as to touch the bee?

3. Catch a bee by the wings as she is at work. Note the pollen on her back and on her hind legs.

4. Strike a flower and notice how the pollen is carried by the wind.

5. If there is a microscope at school, look through it at a pollen grain.

6. Taste the stickysubsta nce on the stigma of a morning-glory.

7. Dissolve a few grains of sugar in a teaspoonful of water. Put a few drops of the solution on a small piece of glass. Drop pollen grains of acacia or oak tree blossoms into the liquid and place the material in a moist chamber. This may be made by inverting a tumbler over a saucer lined with a moist blotter. In a few hours examine the germinating pollen grains with a microscope.

IMPROVEMENT OF PLANTS

Pollination. When the pistil of a plant ripens, the sticky sugar-like substance forms on the stigma. If a pollen grain falls into this liquid, it germinates (Exercise 7) and sends a long tube down the style into the ovary and finally into an ovule (Fig. 111).

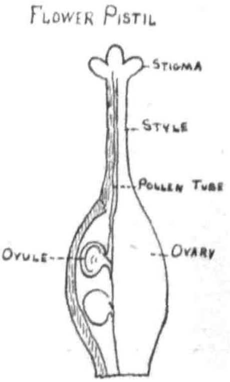


FIG. 111.

Fertilization. At the end of this long pollen tube is a tiny bit of substance (nucleus) which unites with a substance (nucleus) in an ovule in the ovary. The ovule which is ready, yet which has been

sleeping, now is awakened and a seed is formed. If the bit of substance from a pollen grain fails to reach the ovule, it finally dries up and the seed never forms. The union of these two bits of substances is called fertilization, and it results in new life. This is Nature's great work to make new life. Not only to make a new plant, and a new animal, but to make a plant and an animal better than the parent plants and the parent animals. The union of the two substances from weak plants or from weak animals results in weak life.

Cross-pollination. If you followed suggestion 3, under "Home Studies" in the previous lesson, you found some of the flowers with the anthers above the stigma of the pistil. However, at times, the stigma was above the anthers. Due to these arrangements, "self-pollination" is prevented. In some cases self-pollination, the union of the pollen and the ovule substances, or "nuclei," of the same plant, gives poor seeds, which result in weak plants. Cross-pollination, or the meeting of the nucleus in the pollen tube from one flower with the nucleus in the ovule of another flower of the same kind, gives strong seeds, which produce large, showy flowers.

Exercises 2, 3, and 4 show two natural means to bring about cross-pollination: (1) by insects, (2) by wind.

You have learned in Exercise 1 a way used by man to bring about cross-pollination. Have you seen a red

and white carnation? It was made by crossing a red with a white flower.

Thus, outside of the proper use of tools and fertilizers, there are two best ways for you to improve plants: (1) by seed selection, (2) by artificial cross-pollination.

Pollen is necessary to plant life. Plants have many ways to protect their pollen. (1) Most flowers protect the pollen from the dew by closing; (2) many flowers droop or close at the approach of rain; (3) some flowers have their stamens and pistils wrapped in twisted petals — such as those of beans.

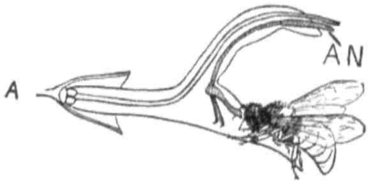


Fig. 112.

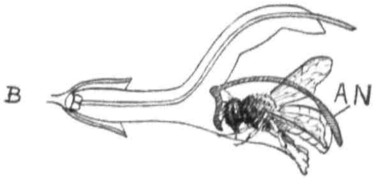


Fig. 113.

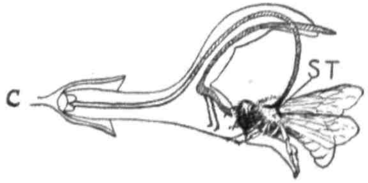


Fig. 114.
AN = anther.
ST = stigma.

Natural cross-pollination. If you observed closely in performing Exercise 2, you noticed that insects visited some flowers more than others. Flowers attract insects in many ways. The bright colors of the corolla are sometimes likened to

signboards advertising the presence of sweet nectar. It is said that bees like blue and violet colors and dislike reds and yellows. Do you think this is true?

Many flowers, particularly those that bloom at night, are sweet-scented to attract insects. Such flowers are usually white, and hence more easily seen. Insects can see but a short distance; probably they are attracted first by the odor from the flowers and are then directed to the nectar by the showy petals.

Flowers of grains, pines, etc., are cross-pollinated by winds. The light grains of pollen may be blown hundreds of miles.

Exercise 2 probably led you to see that many flowers are formed for insect visits. The weight of a bee on the lower lip of a pea flower may cause the flower to open. A smaller insect would be too light to cause this to happen. Thus this flower keeps out small insects which would rob it of nectar and pollen and which would not help in cross-pollination. Some plants have sticky hairs inside of the flower tube to keep small robbing insects out.

Questions

1. What is meant by pollination?
2. Explain the process of fertilization.
3. What is Nature's great work?
4. Explain cross-pollination; self-pollination.
5. Name two natural ways for bringing about cross-pollination.

6. What is meant by artificial cross-pollination?
7. How may plants be improved?
8. Tell something of Mr. Burbank's work.
9. How does Nature protect the pollen of flowers?
10. How do flowers attract insects?
11. What is meant by "robber insects"?

Home Studies

1. Make a list of all the ways you know to improve crops, vegetables, cereal, fruit.

2. Ask the farmers in your vicinity what they are doing to improve their farm yield.

3. What are you doing to improve your own garden?

4. Visit a nursery and see how cross-pollination is brought about.

5. Read what Mr. Burbank has done to improve plants.

Note. Start Exercises 4, 5, and 7, Chapter XXVII. Read the other exercises of this chapter. Plan to start Exercises 1, 2, 3, 8, and 10, Chapter XXIX, very soon.

A SECOND REVIEW OF CHAPTERS I TO XXIV INCLUSIVE

1. Name the points which make an ideal seed bed.

2. What effect has lack of sunlight on a weed, on a tree, on an animal?

3. Tell how to beautify a city home, a school yard, a farm. What reason can you think of for making these more attractive?

4. How may water be kept from running off the land during a rain storm? How may moisture be kept in the soil?

5. What points should be borne in mind in selecting a city or a rural home?

6. What is gained by helping one another, by coöperation?

7. Name the wastes in the home and on the farm. How might these be prevented?

8. Does your community need better streets, better roads, better lights, better schoolhouses? Is anything being done to improve them? Why not?

9. What is meant by crop rotation? By soil inoculation?

10. What does the dandelion gain by having its flowers lifted high from the ground?

CHAPTER XXV

IMPROVEMENT OF SOIL

Exercises

1. Lay off a portion of your garden in checks, as explained in Chapter VII. Make the checks 4 × 4 feet. Treat the plats as follows: —

No. (1) Broadcast on the surface and stir in eight or ten ounces of nitrate of soda.

No. (2) Add 1 lb. of acid phosphate.

No. (3) Leave vacant as a check.

No. (4) Add muriate of potash, about 4 oz.

No. (5) Add nitrate of soda, 8 oz., and muriate of potash, 4 oz.

No. (6) A mixture of potash, 4 oz., and acid phosphate, 1 lb.

No. (7) A mixture of potash, 4 oz., acid phosphate, 1 lb., and nitrate of soda, 8 oz.

No. (8) Stir in a small amount of wood ashes.

No. (9) Add bone meal until the ground is white. Stir and mix it well with the soil.

No. (10) Add lime, about one pailful.

No. (11) Stir in two inches of well-rotted manure.

(Ask your teacher to send to a manufacturer of commercial fertilizer for the above.)

Grow the same kind of seeds in all the plats, and give them all the same treatment. Observe results each day. (4 wk.)

2. If land cannot be obtained for the exercise, use chalk boxes containing sand, and use smaller amounts of fertilizer.

Divide the above amounts by 8, to determine proper proportions. Tin cans or pots may be used. Add nitrate of soda, $\frac{1}{2}$ teaspoonful. Acid phosphate, one teaspoonful. Muriate of potash, $\frac{1}{4}$ teaspoonful. Make up mixtures as outlined in Exercise 1.

3. With the assistance of your teacher make up 1 per cent solutions of muriate of potash (M–P), acid phosphate (A–P), nitrate of soda (N–S), muriate of potash and acid phosphate, muriate of potash and nitrate of soda, muriate of potash and acid phosphate and nitrate of soda, manure. Use distilled water. Germinate wheat seeds; after the roots are well formed, suspend the seeds in the solutions, as shown in Fig. 115. Use fine-meshed netting. The stems will force themselves through the cotton. Prepare one solution very strong.

4. Select two plats of land 10 × 10 feet. Sow half a pint of barley, two or three quarts of soil taken from a field in which clover or alfalfa has been grown, and half a pound of alfalfa in one. Rake it all in. Treat the second plat in a like manner, omitting the soil containing the bacteria. Cut the barley before it heads out. Observe the growth of the alfalfa and its roots from time to time.

5. Try to find a crop growing on land previously planted to a legume. Compare the crop to one grown on land not so treated.

You have learned that soil may be improved by deep, thorough plowing, by thorough cultivation, and you have learned something about plant foods.

Air and soil food. You have learned that much of a plant's food is obtained from the air by the leaves, yet without the soil foods, plants could not live. We cannot help plants very much to obtain air food, — namely,

carbon, —but we can help the plants to be strong by putting food in the soil. Chapter XVIII told you that plants particularly need nitrogen, phosphorus, potash, and lime, and now you have learned more definitely how each may be furnished to the soil.

Loss of fertility. Often it is quite necessary to help plants by adding fertilizers, for soil may lose its fertility, (1) by being washed out by heavy rains, (2) by poor drainage so that the soil bacteria are killed, (3) by bringing alkali to the surface through excessive irrigation with little drainage, (4) by growing the same crops year after year. This loss of fertility may be prevented and remedied by (1) cultivation and growing of "cover" crops to prevent washing, (2) drainage and use of lime, (3) less irrigation and better drainage, (4) fertilization.

Nitrogen. Nitrogen is the most important of plant foods. It makes up four fifths of the air that we breathe. While it is so very abundant, it is the most expensive of fertilizers when manufactured. It costs about 18 cents a pound as a commercial fertilizer. It seems strange that a food (a gas) that is so plentiful should be so expensive. A human being on a raft in the ocean may die from lack of water (Chapter XXII). A plant living in nitrogen may die for need of it. A plant can only use nitrogen after it is fixed in the soil. This may take place in three ways: (1) by the use of commercial fertilizers, (2) by the addition of humus, (3) by the aid of nitrogen-fixing bacteria.

Barn manure. Manure is far less expensive and far more easily obtained as a source of nitrogen than commercial fertilizers. Manure makes the best of fertilizers. It not only adds nitrogen to the soil, but also

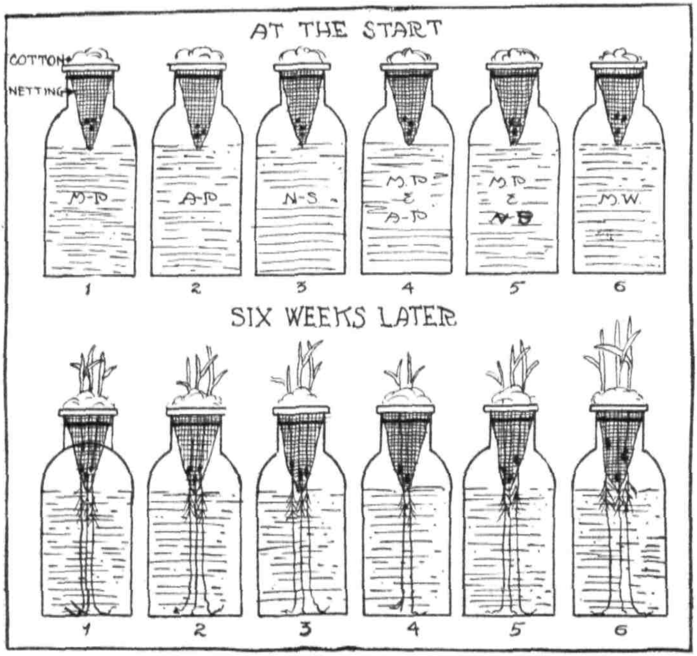


FIG. 115.

phosphoric acid and potash. Compared with the value of commercial fertilizers, manure from each horse for one year is worth \$27; from each cow, \$35; from each sheep, \$2. Due to wrong management, one third of the

manure is wasted each year, which is a loss of $708,466,000 to the farmers. Manure on the farm should be prized and carefully handled.

Management of manure. If you wish to add this fertilizer to your garden, get it from a barn where it has

Fig. 116. — A prize head of lettuce which was fertilized with sodium nitrate.

been handled properly; that is, piled up day after day and kept moist to prevent "leaching" and loss of nitrogen. Let us hope that lime has been added to the pile often to keep the house flies from breeding. Manure which is spread out may have its food content washed away by rains.

How to add manure. Four ways are used to add manure to soil: (1) by placing it in piles to remain some time before it is spread, (2) by scattering over

the plot by hand or by a manure spreader to be worked deeply into the soil at once, (3) by applying it to the hill or row with the seed, but not in contact, (4) by digging a deep furrow to receive the manure, which is then covered over. For general purposes the second method is the best. The manure should be worked into clayey soil to a depth of four inches, into sandy soil a greater distance. Well-rotted manure may be placed in hills and trenches to force vegetables.

A liquid manure made by mixing a 10-pound lard can full of cow manure with 10 gallons of water may be applied to vegetables and flowers. The application will hurry their growth and give brilliancy to the flowers.

Nitrogen-fixing bacteria. You have learned in Chapter XIX that helpful bacteria work on the roots of such plants as peas, beans, clover, alfalfa, etc. These tiny plants take nitrogen from the air in obtaining their own food and fix the nitrogen in the soil. Legumes will not do well, nor will any plants do well unless the soil contains bacteria. Exercise 4 illustrates to you a method called "soil inoculation," which the farmer sometimes uses to insure a good crop of alfalfa. Another good way to inoculate soil is as follows: (1) in a tub full of water put several spadefuls of soil taken from an alfalfa field; (2) stir each day; (3) draw off the water and use it to soak the seeds.

Potash and phosphorus. See Chapter XIX for the use of these two fertilizers.

Caution. The latter part of Exercise 3 teaches that fertilizers must be used carefully or the plants may be killed.

Questions

1. How may soil be improved?
2. Where does a plant get its food?
3. Name the plant foods which are necessary and which are sometimes missing.
4. How may soil fertility be lost? How may the loss be prevented?
5. Name the methods used in adding nitrogen to the soil.
6. Tell what you can of the value of manure, its care and its use.
7. What is meant by soil inoculation? (Repeated.)
8. How may potash and phosphorus be added to soil? (Repeated.)
9. What happens to an overfed plant?

Home Studies

1. How many plant growers in your neighborhood use commercial fertilizers? (Repeated.)
2. What is the cost of fertilizing an acre of ground with a "mixed" fertilizer?
3. What will happen to our farms if hay crops are shipped away and the manure is wasted?
4. What does it cost to add manure to an acre of land?
5. What method is used in manuring soil in your vicinity? When is the manure applied?
6. Is any care being used to prevent the "leaching" of manure and to prevent the loss of nitrogen in the air?
7. Find a method used by some alfalfa growers by which they irrigate with liquid manure. (Repeated.)

8. Add a little distilled water to a handful of soil taken three or four inches below the surface. Dip a piece of blue litmus paper (your teacher will get you some) in the distilled water and lay it on the soil. What happens? If the soil is acid in nature, what can be done? Try red litmus on samples of soil taken from other communities. What happens?

Free Bulletins

The Liming of Soils — Farmers' Bulletin No. 77.

Barnyard Manure — Farmers' Bulletin No. 192.

Fertilizers for Special Crop — Reprint from Yearbook of Department of Agriculture for 1902, Washington, D.C.

Commercial Fertilizers — Farmers' Bulletin No. 44.

Note. Read the exercises in Chapter XXVI and get material ready for the lesson.

The food supply influences root growth. When possible, place the fertilizer deep in the soil to insure a deep root system.

CHAPTER XXVI

WEEDS

Exercises

1. Examine fields and gardens and note the growth of weeds and other plants during the wet weather, the dry weather.

2. After a heavy frost note the appearance of weeds and garden plants.

3. Put a stake near a weed so that you may know it after pulling up the weed's neighbors. Estimate the number of seeds. (This may be done by estimating the seeds on a branch, multiplying by the number of branches.) Watch the plant throughout the year and count the new plants in the spring.

4. Make a collection of weed seeds. Put the seeds in small vials and tie to a cardboard (Fig. 121). Examine the different seeds with a magnifying glass.

5. Obtain a handful of clover seed. Examine it with a magnifying glass. Are any weed seeds present?

6. Make a collection of the weeds in your garden and in the neighborhood. (Thoroughly cleanse the weeds in alum water — two ounces of powdered alum to one gallon of water. Press between two blotters. When dry, mount on cardboard, using mucilaged paper.)

7. Cut open stems of dead weeds. What do you find? Insects or their larvæ?

To the Teacher. Teach this chapter when the children feel the need of weed study; when the weeds are found first in the gardens.

8. Fill a box full of garden soil. Keep the soil moist. Try to identify each plant as it comes up.

WEEDS

Long ere this you have found plants out of place in your gardens. Plants that are undesirable and are out of place are called weeds. Oats, corn, wheat, and other grains which are scattered by trains become a new type of weeds.

Many weeds which you find now in the garden, such as dandelion, shepherd's purse, pigweed, burdock, chickweed, purslane, etc., were not always considered so much of a nuisance. They were brought from foreign countries to be used for food and ornamentation. Now we have plants which furnish us better food, and the weeds have had no care and have multiplied greatly.

Harmfulness of weeds. Weeds kill other plants, (1) by shading them, (2) by drawing moisture from the ground (weeds flourish during the dry weather while the other plants die), (3) by crowding the other plants, thus taking food from them.

Insects and harmful plants live in and on weeds. The farm should be weed cleared in the fall. There are a great many vacant lots in cities and villages. They do not add to the beauty of these places because they are always overgrown with unsightly weeds. In some cities many vacant lots have been made useful and beautiful by school boys and girls. Weeds do harm

by poisoning stock (loco weed) and by giving a bad taste to milk (wild onion, alfilaria).

The scattering of weeds. Weeds are scattered in many ways: (1) by the transfer of entire plants or parts of plants. They may be carried by wind, water, and animals. As stated before, many foreign weeds were introduced into America for food purposes. (2) By seeds. Many weeds, such as the dandelion, have parachute arrangements to which seeds are attached. The wind carries such seeds many miles. Weed seeds often fall into running streams and are scattered widely. Birds swallow weed seeds which are indigestible and they are deposited here and there. Cocklebur, foxtail, and weeds of a like nature are scattered by seeds inclosed in a prickly coat often covered with little attachments. These stick in the hair of stock and the clothes of man. Many weed seeds have wings. Mustard seeds are so small that they lodge in the slit of oat seeds and are thus carried about. The

FIG. 117. — Beggar's-ticks.

FIG. 118. — Burdock head.

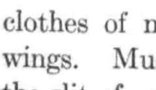


FIG. 119. — Bur clover.

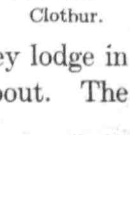


FIG. 120. — Clothur.

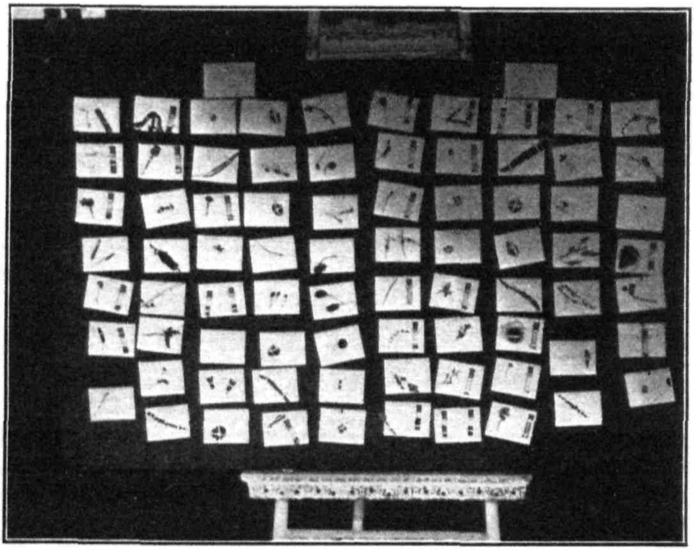


FIG. 121. — A collection of weeds.

Russian thistle, plantain, and other weeds have been distributed through commercial seeds such as clover, alfalfa, and flaxseed. Often weed seeds are carried in hay, packing, etc., by the railroads.

FIG. 122.—Dandelion.

Weed vitality. Weeds are the most successful plants. Frost seldom kills them. They flourish during wet and dry weather. They grow vigorously and multiply rapidly under conditions

which kill the useful plant. Exercise 3 gave you some idea of the great number of seeds a weed produces. Weed seeds may lie in soil 15 to 25 years and then germinate. Thus we see why a weed is such a successful plant and why it springs up at an unexpected time.

The following results were obtained in an Ohio school after examining three plants of each weed.

Name	Number of Seed Estimated	Space Covered
Willow Lettuce .	2435	105 sq. in.
Indian Mallow .	2480	315 sq. in.
Cocklebur . . .	270	408 sq. in.
Wild Carrot . .	880	233 sq. in.

To show the rapidity of spread, the following estimates were made, supposing each seed to produce an average plant.

Name	Space Covered 2d Year	Space Covered 3d Year
Willow Lettuce .	$6\frac{1}{2}$ sq. rd.	99 A.
Indian Mallow .	20 sq. rd.	309 A.
Cocklebur . .	$2\frac{2}{3}$ sq. rd.	$4\frac{1}{2}$ A.
Wild Carrot . .	5 sq. rd.	29 A.

Dr. Beal estimated the increase of different weeds in Michigan in 30 years from 25 to more than 250 kinds.

How to control weeds. In order to control a weed it is necessary to know its habits of life. Weeds are grouped according to their length of life.

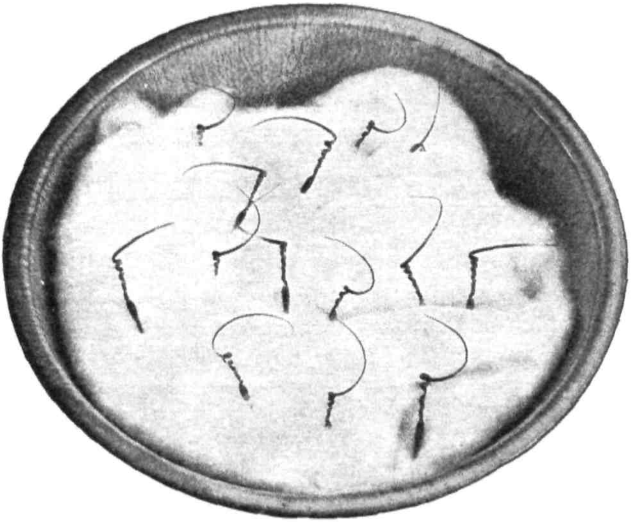


FIG. 123.—Filaree seed entering moist cotton.

Annuals are weeds which produce seeds each year and die. The life cycle takes but one year. Pigweed, lamb's-quarters, purslane, and great numbers of other weeds are annuals.

Biennials are those weeds which produce seed in two years and die. Two years make a life cycle. Wild carrot, thistle, burdock, mullein, etc., are biennials.

Perennials live year after year. They grow from

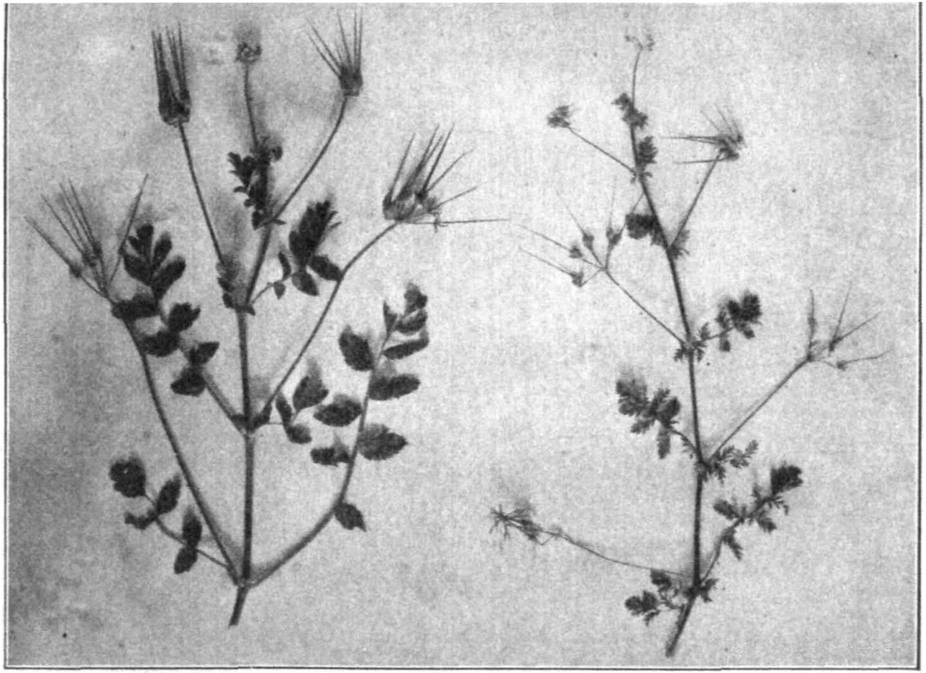


FIG. 124. — Two types of filaree.

seeds and rootstock. Dandelion, Bermuda grass, wild onion, are perennials.

There are a few general methods to be used in destroying any one of the three classes of weeds. (1) Try to prevent the scattering of weed seeds through impure

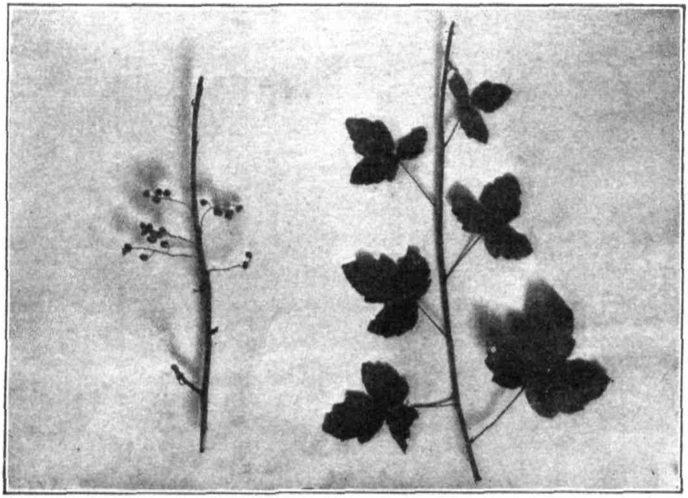


FIG. 125. — Poison oak.

commercial seed, manure, etc. It is much better to prevent seeding than to destroy the weeds. (2) By persistent cutting back of the green parts of weeds and "undercutting" before the plants appear, the roots may in time be killed. (3) Continual cultivation will finally rid the soil of many weeds. (4) Weeds should

never be allowed to go to seed. (5) Burning over a piece of land will kill many weed seeds.

Land overrun with perennials should not be cultivated for the purpose of destroying such plants when the ground is wet. The roots are only broken, and each small piece sends up a new plant. If such cultivation takes place during dry weather, sunlight and frost may kill the roots.

Weed values. Weeds have some use in the world. Dandelion, purslane, watercress, plantain, and numerous other weeds are used for food. In early New England days many helpful medicines were made from weeds. Even now medicines are made from weeds. Weeds not only act as a fertilizer when plowed under, but they keep the grower cultivating his soil, which insures soil moisture for plant growth. On hillsides many weeds are allowed to grow to hold the soil from being washed away by rains.

Questions

1. What are weeds?
2. How were many weeds introduced?
3. How are weeds harmful?
4. Explain how weeds are scattered.
5. Why is a weed such a successful plant?
6. Name and define the three classes of weeds.
7. How may weeds be controlled? Find out how weeds may be cut beneath the surface of the soil before they appear.
8. In what ways are weeds of use?

Home Studies

1. What weeds are most common in the pasture? The garden? The cornfield?

2. What farms in your neighborhood have the least number of weeds? How does each farmer destroy weeds?

3. Find out how the following weeds are scattered: wild morning-glory, prickly lettuce, cocklebur, burdock, foxtail, and alfilaria. Examine the weeds.

4. How does the farmer attempt to control mustard in the grain field?

5. Do the farmers regulate their plowing so as to control weeds?

Free Bulletins

Weeds and How to Kill Them — Farmers' Bulletin No. 28.
Thirty Poisonous Plants — Farmers' Bulletin No. 86.
Weeds Used in Medicine — Farmers' Bulletin No. 188.

REVIEW QUESTIONS ON CHAPTERS XXIII TO XXVII INCLUSIVE

1. What is the main use of a flower?
2. Name the essential parts of a flower.
3. Why does a plant form so many seeds?
4. Explain the process of fertilization.
5. What is Nature's great work?
6. Name natural ways for bringing about cross-pollination; artificial.
7. How may plants be improved?
8. Are the farmers in your vicinity trying to improve their plants? Why or why not?
9. How may soil fertility be lost? How may the loss be prevented?
10. Why should a farmer keep stock?
11. How are weeds harmful?

CHAPTER XXVII

INSECTS

Exercises

1. Examine the plants in your garden for insects. If many are found, note the general appearance of the plants upon which they rest.

2. See if any plants are failing. If some are found, note the character of the injury and the insects found on the plants.

3. Capture a butterfly and a beetle. Examine the mouth-parts of both.

4. Put caterpillars in a lamp chimney closed with netting and placed in a pot of soil (Fig 126). Feed the caterpillars daily. Place a twig in the chimney for the caterpillars to crawl upon.

Fig. 126.

5. Knock the plant lice from a branch until but a half dozen remain. Cover the branch with a chimney as above. Count the insects each day. Examine the mouth-parts of a plant louse with a magnifying glass as it is obtaining its food.

6. Look in crevices for pupa cases. Bring them to the schoolroom.

To the Teacher. When insects are found at work in the gardens, take up the study of this chapter. The children have a vital interest in the study of the cabbage butterfly if it means the death of the larvæ or the loss of their cabbages.

7. Place a small dead animal in an out-of-the-way place. A few days later, look for small white oblong eggs $\frac{1}{16}$ inch long. If the dead creature is a bird, lift the feathers and look for the eggs. Preserve a few in alcohol. A few days later examine the body for "larvæ" or "worms" (Fig. 127). Preserve a few in alcohol. Next, small oblong reddish brown cases will be found. Place a few of these pupa cases in alcohol and a few in a chimney covered with netting. Note results in a week or so. The insects which come out are flesh flies.

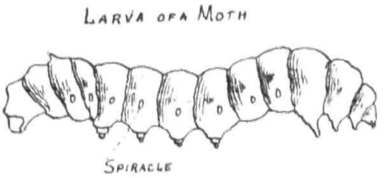


FIG. 127.

8. Find as many insect homes as you can.

9. Examine the breathing pores on the sides of a larva (Fig. 127).

As a rule, each kind of a plant has an insect enemy, and since our happiness depends on plants, most insects are enemies of ours. The codling moth destroys from 3 to 20 per cent of the apple crops of the United States each year. Other insects with this moth cost the United States each year at least $1\frac{1}{2}$ billions of dollars in spoiled crops. While insects are so harmful, they are not to blame. In order to live they must attack plants. However, when they interfere with us, they must be destroyed.

Insects known by their work. Generally, each insect has a peculiar way to get its food, and the method shows on the plant. The plant may wilt, the leaves

may have holes eaten in them, or they may be entirely devoured, or may only curl and shrivel. Sometimes plants are cut off close to the ground. Each of these indicates the work of a specific kind of insect.

Kinds of insects. The adult insect has six legs and usually has wings. Bees and most insects belonging to this class have four wings. Most flies have two wings, yet a few kinds are wingless. Butterflies and moths have four broad wings covered with scales. Beetles have four wings, two hard wings covering two thin folding wings. All of these classes pass through four stages of development, — the egg, the larva, the pupa, the adult. Usually the larval form is the growing or feeding stage of the insect. Most insects are harmful at this period. Some insects, such as the sand cricket and the "cucumber" beetle, are harmful as adults because of their feeding habits. During the pupa stage the insect rests. The adult insect usually dies after laying eggs. The aim of insect life seems to be to make *more insects* and to make each *better than the last.* Bugs have mouth-parts for sucking and, with the exception of a few wingless varieties, have four wings. Usually the fore part of the outer wings is hardened while the latter part is membraneous, giving such insects the name half-winged. There are other classes of insects which you may study later.

Methods in obtaining food. If something is wrong with a garden plant, examine it carefully. Note the

insects on the plant and examine the mouth-parts. If the plant is wilting or the leaves are curling and shriveling, it is probably due to insects which are sucking the

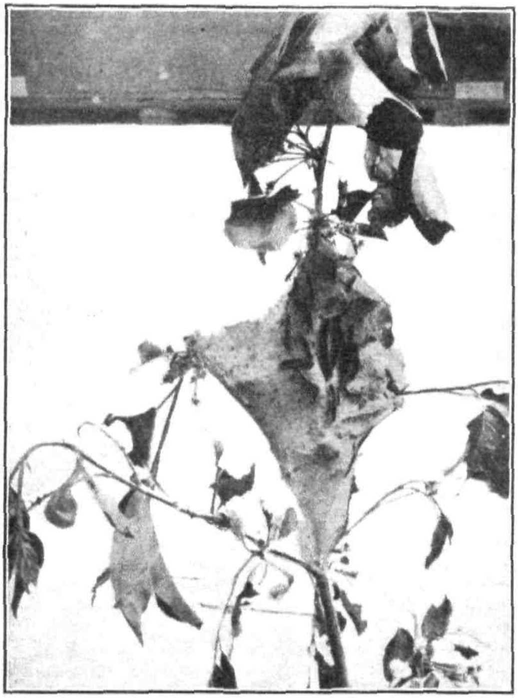


FIG. 128. — Leaves eaten by "tent" caterpillars.

sap. On the other hand, if the leaves have been eaten in spots or as a whole, some insect with a biting mouth-part has been at work (Fig. 128).

Methods of control. Insects that obtain their food by biting may usually be destroyed by poisoning the leaves eaten. (See Appendix for the use of poisons.) Insects which suck their food through the covering of the plant can only be killed by using liquids, powders, and gases that cause death by reaching the insects' bodies directly. Thus the insects are suffocated through closing their breathing pores. (See Appendix.)

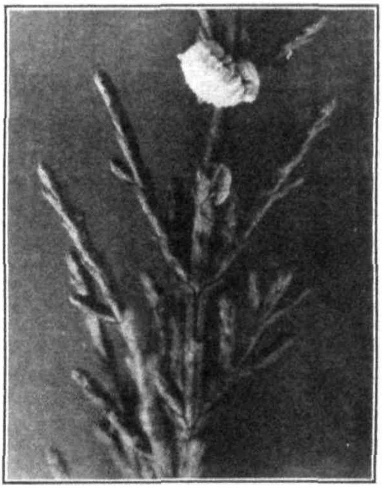


FIG. 129. — Larva of a ladybird-beetle devouring a mealy bug.

Life histories. It is often necessary to study the stages of an insect's development to identify the insect that is being studied and to find the period during which the insect may be destroyed best. The house fly may be controlled most readily by removing the breeding place, — a manure pile, — rather than by killing the adult.

Insect multiplication. "Certain moths deposit hundreds of eggs in a season, and were each egg to hatch and each insect to come to maturity and go on producing at the same rate, the entire earth in a few years would

be carpeted with crawling caterpillars, and the moths in flight would cover the earth like a blanket of fog, and in four years the foliage of the United States would be destroyed."

Questions

1. What harm is done by insects?
2. Name a few different kinds of insects.
3. Name the four stages in the development of a butterfly and describe each.
4. What seems to be the aim of insect life?
5. What are bugs? Name a few.
6. What two general methods do insects use in obtaining food?
7. When found on a plant's surface how may insects with biting mouth-parts be controlled? Those with mouth-parts for sucking?
8. What is meant by the life history of an insect? What is the need of life history study?
9. Tell something about the rapid increase of insects.

Home Studies

1. Find out what insects are harmful in your vicinity to apples, oranges, peaches. What methods are used to control them?
2. Find out how and when poisons are sprayed on plants.
3. How may grasshoppers be controlled?
4. Name all the natural things that keep insects from multiplying too fast.
5. Learn the story of the ladybird beetle and the cottony cushion scale (Fig. 129). Also the story of the ichneumon flies.

6. Why are most insects the same color as the object on which they rest?

7. What is the use of the "prong" on the rear part of a tomato "worm"?

8. Do orchardists spray every season whether insects appear or not? Why?

9. At what time in the day do orchardists and gardeners spray? What time of the year? Why?

Free Bulletins

The Control of the Codling Moth — Farmers' Bulletin No. 171.

Insecticides and Fungicides — Farmers' Bulletin No. 146.

Scale Insects and Mites on Citrus Trees — Farmers' Bulletin No. 172.

Usefulness of the American Toad — Farmers' Bulletin No. 196.

CHAPTER XXVIII

BIRDS

Exercises

1. Follow a bird in its activities for ten minutes. Note closely what it is doing as it hops and flits about.
2. Note the kind of birds seen near the ground, high in the trees, in the meadow.

The lesson on weeds told of the enormous quantity of seeds produced by plants. This, with the help of man to protect plants from their enemies, is all that saves plants from disappearing. Insects and other animals eat them; minute plants live upon the more important ones.

The lettuce in a small school garden was visited each day by an animal and snipped off. The white-crowned sparrow proved to be guilty. The boys and girls at once concluded to destroy the sparrow. However, after close watching, the birds were seen to eat insect after insect. The class decided that the sparrows did more good than harm. The lettuce was saved by covering it with brush. The birds as a whole do a great deal of good and little harm.

To the Teacher. Introduce the study of birds after they are met in relation to the garden activities.

Why birds should be protected. Do you know of anything that combines such joyous qualities, such delicate and gorgeous colors, — Nature has drawn most lavishly from her experimenting palette, the twilight sky, — such grace in movement, and such gift of song as do the birds?

If you were one of these "sky gems" sitting in the morning light, singing to your mate, and she secure in your love, answering in sweet bird talk, when suddenly into this beautiful world should come the dreaded "crack," and your mate with eyes full of agony should fall from the nest, would you not fly and fly until you dropped from exhaustion, for nothing would matter now?

Can you solve the following problems: "Suppose there are 50 apples in a peck; how many might a codling moth spoil if she lay 50 eggs on as many apples, and half of these eggs hatch female moths, and the second brood again, and each lay 50 eggs on as many apples?" Answer. — 26 pecks.

"If a downy woodpecker eats only one codling moth larva each day from November to April, inclusive (180 days), what might be the value of its work to an orchard if apples are worth 50 cents a bushel?" Answer. — $585.

In giving a description of conditions after a volcanic eruption, which occurred in Guatemala, a coffee planter said: "One of our greatest troubles was that of sickness, owing to the balance of nature being upset by the

eruption, which, by killing all the birds for some hundreds of miles, enabled the flies, mosquitoes, and rats to multiply to such an extent that life to man became nearly unbearable. The immediate consequence was an epidemic of malaria, which cost more lives than the eruption itself — many times more. It has passed away, happily; since birds have come again, the breeding of these pests is checked, and the district again enjoys the excellent reputation for health that it deservedly had before."

Authorities have observed one pair of grosbeaks feed their young in one day of eleven hours, 800 larvæ of insects. Three thousand ants have been found in the stomach of a "flicker" at one time. Five hundred mosquitoes were counted in the stomach of a night-hawk. A pair of nesting wrens took more than 600 insects from a garden in one day. Swallows eat more than 1000 flies a day. The stomach of a quail held 100 potato beetles. Another had eaten 500 chinch bugs.

Bird authorities of Massachusetts estimate one day's work by the birds in that state to be the destruction of 21,000 bushels of insects. In Nebraska 170 carloads of insects are destroyed each day. While thousands of insects are destroyed through other natural agencies, just think for a moment of the number of insects all the birds in the whole United States might destroy in one day and in one year.

This chart (Fig. 130) shows the proportionate amount of food the different birds eat. Not only do birds eat immense numbers of insects as they hop about from

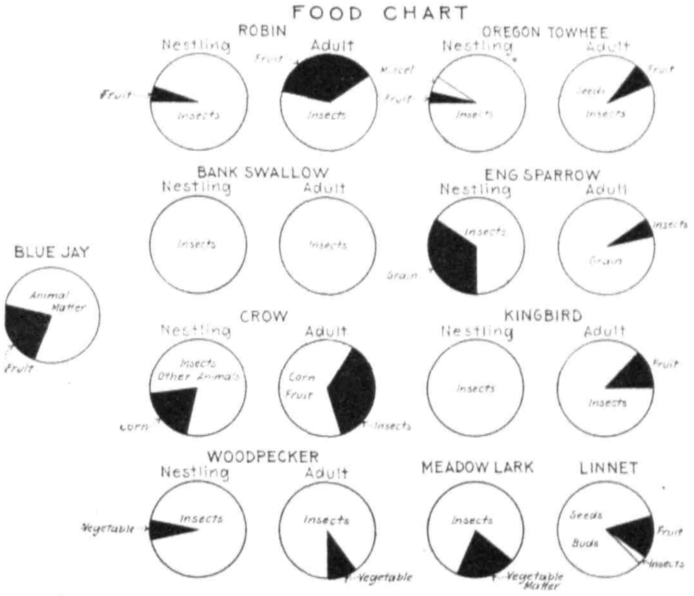


Fig. 130.

daylight to dusk, but they eat thousands of weed seeds each day.

The balance of nature. Chickens and rabbits are tidbits to coyotes. The coyotes in a mountain country had become so numerous, so the story goes, that they destroyed many chickens. The authorities put a

cash bounty on the coyotes; that is, for each dead coyote money was paid. Soon the coyotes became very scarce and the jack rabbits very numerous, for the coyotes had fed upon them, thus keeping the rabbits in check. Now the rabbits fed in the gardens and orchards and

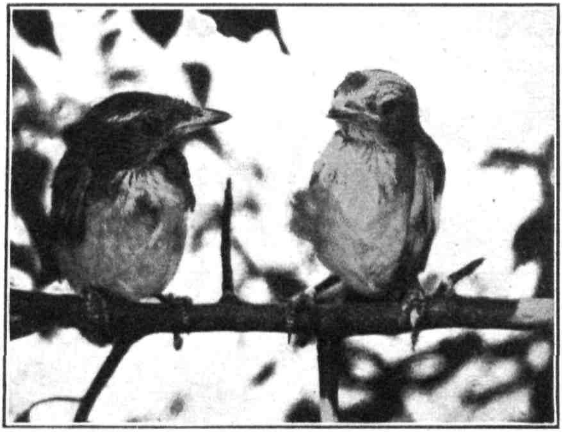


FIG. 131. — Two satisfied jays.

became more harmful than the coyotes. The bounty was taken from the coyotes; they multiplied again and held the rabbits in check. One animal balanced the other.

We have learned how rapidly insects increase in numbers. If it were not for the birds and other natural checks, the insects would soon overrun the earth.

How to protect birds. Build bird houses, report any violations of the bird laws, watch the cats, punish

the blue jays and other harmful birds as the law punishes human beings that take life, never put out poison, arrange drinking and bathing places, never aid in long imprisonment of wild birds. Girls should never wear birds on their hats.

How to study the birds. First learn this quotation: "*A bird in the heart is worth more than a hundred in*

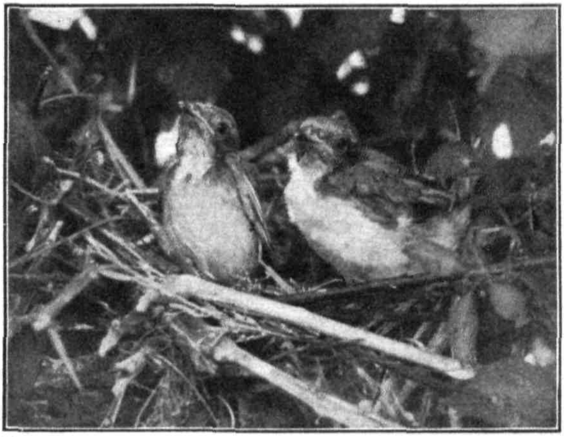


FIG. 132. — Looking for mother.

a notebook." Second: Learn repose. Third: Learn to listen. Fourth: Learn to see.

To study birds most successfully, proceed to a spot frequented by birds with your notebook and if possible a good binocular field glass (eight to ten diameters). Sit quietly and patiently and you will be rewarded by

some shy but curious friend. Raise your glasses slowly and take a detailed description, following the notebook outline given in the Appendix.

One of the greatest pleasures the birds may offer you is through their songs, so learn to listen for and recognize the birds' voices at all times, whether bird hunting or at work. Whenever a new note is heard,

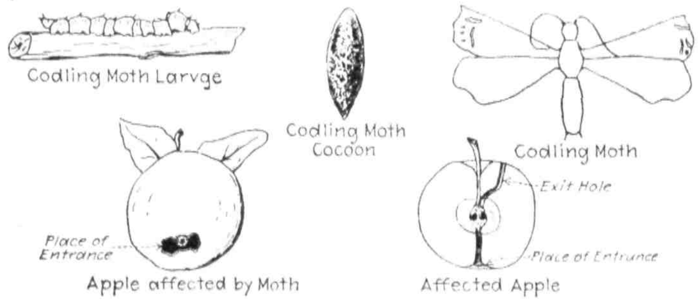


FIG. 133.

trace it to its maker. Accurate recognition is often dependent upon the bird's song or call. If you are musically inclined, place the songs of the birds to notes and try imitating their songs on musical instruments.

Learn to see correctly and to interpret wisely. Many see the apple pecked and the wheat kernel disappear, but do not see the quick efforts of the same birds which mean the death of a codling moth larva (Fig. 133)

(the small "worm" found in apples) or a grasshopper. Cultivate sharp eyes for the good work done as well as for the evil, and you will have a good basis for determining the worth of a bird.

Migration. With the failure of their food supply, and the coming of the cold weather, many birds become

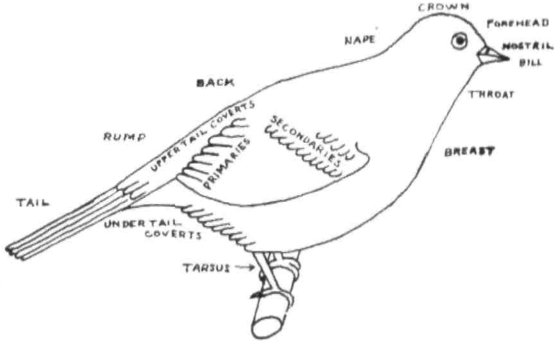


FIG. 134.

uneasy and, following some instinct, they move southward to the Gulf States. They travel at night singly, in pairs, and in flocks. Such birds are called summer residents in the middle areas. Many in the far north, because of the great cold and a short supply of food, move to the middle areas and are called winter residents. Others stay in one region the year round — permanent residents. Again, others move continuously from day to day and are called transients.

SOME BIRD LAWS

Federal laws. "The importation of the English sparrow and other injurious birds is prohibited."

All hunting or killing, etc., in the Mount Rainier and the Yellowstone National Parks is prohibited.

State laws. State laws differ. In California all wild birds excepting the cooper's hawk, the sharp-shinned hawk, the duck hawk, the great horned owl, the blue jay, the linnet, the shrike, and the English sparrow are protected.

Any person, who, in the state of California, "shall at any time hunt, shoot, shoot at, pursue, take, kill, or destroy, buy, sell, give away, or have in his possession — except those above mentioned — or shall rob the nest, or take, sell, or offer for sale, or destroy the eggs of any wild bird, other than those above named, is guilty of a misdemeanor" and is liable to a heavy fine or imprisonment. Game birds are not included under this head, but are protected by the game laws.

No part of the plumage, skin, or body of any bird protected by this section shall be sold or had in possession for sale, irrespective of whether said bird was captured within or without the state.

It is unlawful to take or kill at any time any mountain quail, swan, ibis, wild pheasant, bobwhite, quail, imported quail or partridge, grouse, sage hen, or wild turkey.

Severe penalties are imposed for taking the eggs of quail and other game birds.

The fine for killing a blue crane is not less than fifty dollars and possible imprisonment of not less than fifty days.

Questions

1. Give three reasons for protecting birds.
2. Look at the food chart and tell why the robin, the bank swallow, etc., are helpful.
3. How may birds be protected?
4. What methods should be used in studying birds?
5. Name some bird laws.
6. What birds are unprotected?
7. What is meant by the "balance of nature"? Give examples.
8. Why do birds migrate? What are permanent residents, transients, winter visitors, summer visitors?

Home Studies

1. Make a map in winter of the bird nests.
2. Make a list of the birds you know. Group them according to migration periods.
3. Study one bird — its movements, song, flight, habitat, etc. Use the outline in the Appendix.
4. Make a bird table out of the reach of cats. Arrange a bathing place and feed the birds daily.
5. What are the Audubon societies for? Is anything done in your neighborhood to protect the birds?
6. Do the farmers shoot meadow larks in your vicinity? Should they?
7. Learn to know the songs of at least ten birds.

FREE BULLETINS

Some Common Birds — Farmers' Bulletin No. 54.

The Blue Jay and Its Food — Reprint from the Yearbook Department of Agriculture, 1896.

Some Facts about the Migration of Birds — Reprint from the Yearbook Department of Agriculture, 1903.

Birds as Weed Destroyers — Reprint from the Yearbook Department of Agriculture, 1898.

The Food of Nestling Birds — Reprint from the Yearbook Department of Agriculture, 1900.

How Birds Affect the Orchard — Reprint from the Yearbook Department of Agriculture, 1900.

The Relation of Sparrows to Agriculture — Farmers' Bulletin No. 15, Washington, D.C.

Birds of California — Biological Survey Bulletin No. 30, Washington, D.C.

NOTE. Read the exercises of Chapter XXIX. Follow instructions given.

CHAPTER XXIX

PLANT DISEASES

Exercises

1. Pick two geranium leaves. Coat both sides of one with vaseline. Roll both leaves and place them in separate test tubes. Cork both tubes. *Note results from day to day.* Account for the difference in moisture on the sides of the tubes. (Repeated from a previous chapter.) (3 da.)

2. Vaseline all of the leaves of a small living plant. Note results each day. (1 wk.)

3. Expose bread to the air. Keep the bread moist. Observe daily. (1 wk.)

4. Find a mushroom or toadstool (Fig. 135). What is its color? What does its food come from? Examine the roots, stem, and cap.

5. Mucilage a piece of paper. Cut off the top of a toadstool and place the gill side down on the paper. Examine a day or so later. (2 da.)

6. Open a puff ball. Note the immense number of minute particles or spores. Blow them into the air.

7. Strike an eraser. Notice how the particles of crayon dust disappear from sight.

8. Draw a knife through a decayed spot in an apple. Without cleaning the knife cut into a sound apple and put it aside. In a few days examine the second apple. (1 wk.)

To the Teacher. This chapter should be studied when the children feel the need of protecting their plants from fungous diseases.

9. Examine the young plants and the germinating seeds about the room. Note the conditions surrounding them.

10. Dip half a dozen seeds in a solution of blue vitriol. Plant these and six others in a chalk box. Note results. (2 wk.)

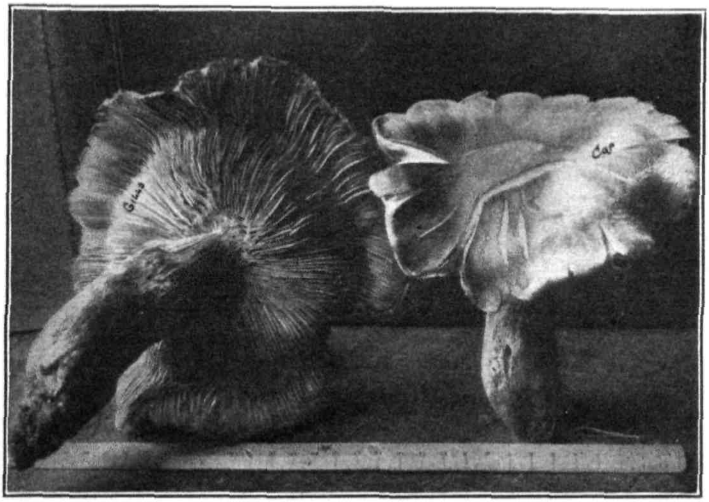


FIG. 135. — A large type of fungi — a mushroom.

Often young gardeners are disappointed in maturing vegetables and other plants because of a mysterious something which slips in and kills them, just as the farmer often loses his crop of peaches and possibly all of his pear trees.

The cause of plant diseases. If you performed Exercise 3 you have a growth of small colorless plants which feed on the bread. This is mold, or fungi (fungus is singular). Fungi are plants which feed on food which

has been prepared for them by other plants and by animals. Fungi may draw nourishment from stems, leaves, roots, fruit, and wherever food is stored. Green plants prepare their food from material taken from the air and the soil. This is stored for future use in the

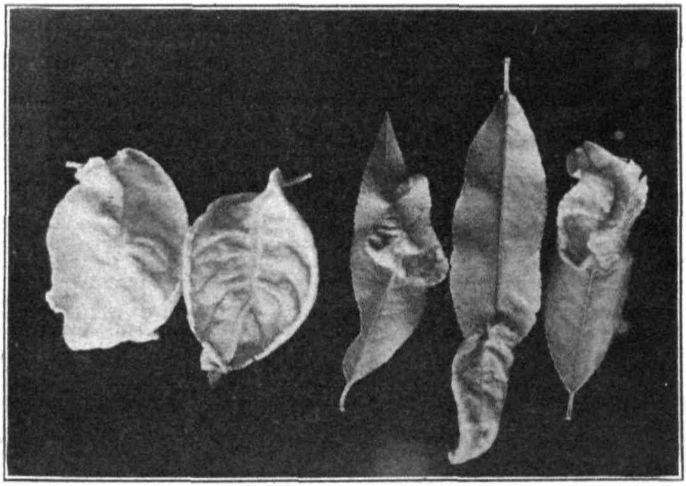


FIG. 136. — Peach leaf curl.

roots, stems, leaves, and fruit. Fungous plants have no chlorophyll and hence must have their food prepared by other plants and animals. Sharp eyes may have seen colored spots in the bread. These were caused by bacteria (Chapter XIX). Such plants as fungi or bacteria are called parasites when the material on which they live is obtained from a living "host," and sapro-

phytes when they live upon dead animal or vegetable matter. Nearly all plants are subject to fungous diseases and many to bacterial troubles. Leaf curl on peach trees, brown rot of the lemon, "blue mold" of the orange, "damping-off" of young plants, potato and apple scab, mildew of roses, carnation wilt, apple mildew, and numerous other plant diseases are caused by fungi. Pear and apple blight, black rot of the cabbage, black knot of the peach, etc., are caused by bacteria.

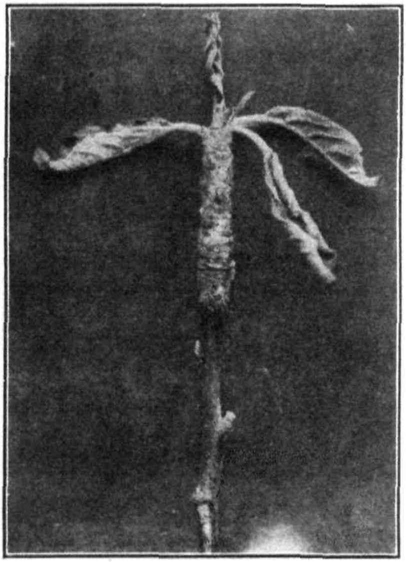


FIG. 137. — Apple mildew.

How fungi multiply and spread. Fungi do not produce seeds, but millions of dustlike spores (Exercises 5 and 6). These are carried by wind, water, insects, birds and other animals — by man (Exercise 8). The air is filled with fungous spores (Exercises 3, 6, and 7). Let us follow a few spores which cause peach leaf curl and which have been caught by the wind. From an orchard

which has had little care, the spores are carried to a neighboring peach orchard. The tiny spores drop in a moist crevice of a leaf — moist because of rain, dew, or "honey-dew." Here a few germinate, send their roots between the particles of leaf tissue, and gradually curl and kill the leaves. The plant cut off from its supply of air food declines (Exercise 2). The parasites flourish, produce millions of spores, and the disease spreads, particularly if the trees are not vigorous.

Often fish which are placed in an aquarium with little room for activity and unable to obtain their proper food, weaken and are attacked by a water fungus which kills them. A salmon in working its way up a rushing brook to spawn may become bruised. Fungous spores attack the bruised spot, the weakened animal cannot resist, and dies. Thus the weakened plant or animal is most subject to fungous and bacterial attacks, while a strong animal may be "immune." The plants in the schoolroom are subject to diseases because of their unnatural surroundings.

How to control plant diseases. In your garden work you may not be troubled greatly by plant diseases. However, you should learn how to prevent and to control them. It is a very hard matter to kill fungi after they have commenced to grow. Prevention is the only sure way to protect plants from diseases. Orchardists find that by spraying their trees with Bordeaux Mixture (see Appendix), in the spring, the fungous spores are

killed and diseases are prevented. If a plant disease gets established in a tree, all affected parts must be pruned off and burned. Rotation of crops often prevents a vegetable or grain disease from getting established.

Often young flower plants and tree seedlings are attacked just above the ground by "damping-off" fungi. The stems are weakened and the plants fall over and die. The young plants only are attacked. Old stems resist the fungi. This disease may be prevented in a measure by keeping the plants on the "dry side" when they appear above the ground; that is, be very careful about giving too much water. Sand and charcoal sifted on the top soil often help to prevent damping-off.

Questions

1. What are the causes of plant diseases?
2. What is the nature of fungi? Of bacteria?
3. How do fungi differ from other plants?
4. What is a parasite? The host?
5. What is a saprophyte?
6. Name five diseases caused by fungi; two caused by bacteria.
7. How do fungi multiply and spread?
8. How do fungi kill plants?
9. What plants and animals are most subject to disease?
10. What is meant by "immunity"?
11. How may plant diseases be controlled?
12. What is meant by damping-off?

Home Studies

1. When and how are plants treated in your vicinity by "fungicides"? What does it cost to spray 50 peach trees each year?

2. What plant diseases are common in the neighborhood?

3. Make a collection of diseased parts of plants.

4. Are the orchards near cleaned of rubbish as soon as pruning is over?

5. How would a farmer control potato scab, pear blight, stinking smut of wheat?

6. Make a collection of fungi.

7. Can you account for the great number of spores developed by fungi?

Free Bulletins

Fungicides and their Use in Preventing Diseases of Fruits — Farmers' Bulletin No. 243.

Spraying for Apple Diseases and the Codling Moth in the Ozarks — Farmers' Bulletin No. 283.

REVIEW QUESTIONS ON CHAPTERS XXVII TO XXIX INCLUSIVE

1. What harm is done by insects?

2. Describe the life history of a fly, a grasshopper, a plant louse.

3. What seems to be the aim of insect life?

4. Why do insects multiply so fast?

5. What is a bug? An insect?

6. How are insects partially controlled by man?

7. How are insects partially controlled by nature?

8. Why are insects usually of the same color as the part of the plant on which they are found?

9. Why should birds be protected?

10. What keeps insects, birds, gophers, rabbits, coyotes, lions, etc., from multiplying too fast?

11. What causes plant diseases?

12. How do fungi multiply and spread?

13. What is meant by "immunity"?

14. How may plant diseases be controlled in a large measure?

CHAPTER XXX

TREES

Exercises

1. Gather a little soil from beneath a tree. Heat in a tin basin. Where did the humus come from?
2. In a wooded spot, turn over the covering of leaves and twigs; dig into the soil. Note the presence of moisture.
3. Examine the banks of a small canyon. Note how the roots of trees and other plants prevent the soil from being washed away.
4. Find out the difference in annual rainfall in wooded regions; in open places.
5. Find out what regions are harmed by floods. Wooded or open?

The uses of trees. Trees are very necessary to our comfort. Limbs and leaves fall, decay, and thus add humus to the soil. Whole trees have been buried for thousands of years and have thus formed coal beds. Roots open the earth. Many decay and enrich the land. Dead leaves act like a great sponge. They keep the rains from running to the streams and finally to the ocean. The water seeps into the soil, where it is held by masses of roots. Each system of roots is like a large tub which holds the water. During the dry weather the trees throw off moisture through the leaves, helping

to keep the temperature low, and the water in the ground feeds the streams and springs slowly. Thus the trees regulate the water supply. They tend to prevent floods during the heavy rains and to keep the streams flowing in dry weather. In China and in parts

FIG. 138. — Ruthless cutting of trees by the small sawmill.

of the United States, acres of land have been wasted by rushing waters. These lands were once covered with trees. With the trees removed, there was nothing to control the waters.

Nature may spend hundreds of years in building a tree which may be cut down in an hour. We are told that if the ruthless cutting of trees is not prevented in

50 years but few will be left. However, if the small trees are not destroyed, and if new ones are planted, there will be no timber famine and fewer floods.

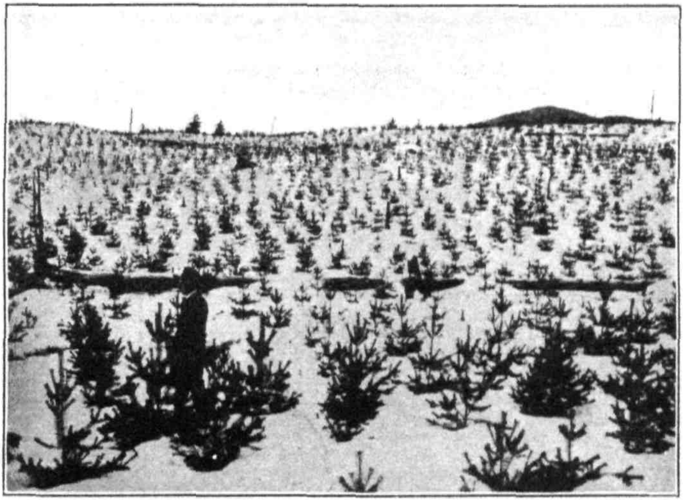


Fig. 139. — Re-foresting the mountains.

TREE GROWING

Your home garden or your school garden is not complete without a few young trees in the nursery. Each pupil should grow a few trees for the beautification of school and home. There should be more trees planted along roadsides, both in the city and the country.

We hope that you have followed the suggestions in Chapter XII and have made a permanent plan for

beautifying your school grounds. In planning trees and shrubs for the yard, select hardy plants, for they will receive less care than those grown in a private home. Elms, oaks, walnuts, and maples are not only hardy, but are long lived and easily grown.

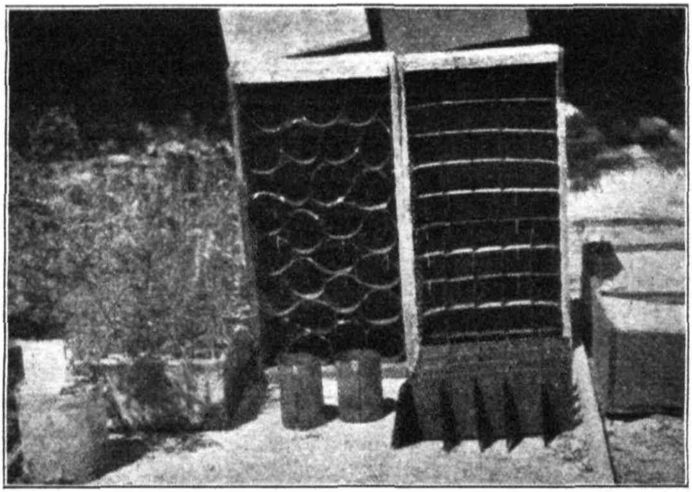


FIG. 140. — Partitioned flats, pasteboard cartons and cylinders.

How to start trees. Seeds longer than $\frac{1}{4}$ inch should be "stratified." Upon a bed of sand 4 inches deep in a box, place the seeds which are to be used. Cover with 4 inches of sand. Keep the sand moist. After the seeds sprout they should be transplanted. Almond pits, peach pits, etc., may be planted 5 inches deep, 6 inches apart, in the open during the spring. Or

FIG. 141. — Ninety-eight varieties of trees growing in cans.

they may be thrown into a hole 6 inches deep and kept wet. The young trees may be transplanted readily.

Treat tree and shrub seeds less than $\frac{1}{4}$ inch long the same as flower seeds. See Chapter IX. For special treatment of seeds, see Appendix.

Transplanting. When true leaves have formed on the plants, they are ready to be moved. Prepare the new seed bed thoroughly. Moisten the new seed bed and the old seed bed 24 hours before transplanting. Take up a young tree carefully, allowing the soil to cling to the roots. Cut off any roots that are bruised. Place the seedling in a hole large enough to receive the roots without crowding or twisting them. Hold the plant in place with one hand and fill in the earth with the other. Pinch the soil close to the tree. Shade the tree with a shingle.

Often seeds are planted in tin cans, paper pots, etc. (Fig. 141), and later without disturbing the trees they are planted in the open, cans, pots, and all. Pots can be made of heavy paper.

Care of permanent trees. If trees are set out in cans or paper pots in the spring, two or three waterings during the vacation will ordinarily carry them through. Surely some one can be found willing to give an hour or so of vacation time to helping others. If there is danger of stock breaking the young trees, make a guard such as is shown in Fig. 142.

FIG. 142. — Monterey Tree-growing Club. Boys making cuttings and tree guards.

The small plants will need such treatment as is given other forms, — thorough cultivation, pruning, etc.

Tree-growing clubs. Why not organize such a club as is pictured in Fig. 142, and help to beautify the roads and public buildings of your city or country?

WHAT TO DO FIRST

See Something

One of the first things is to get acquainted with the trees on the four sides of your block. How many are there? Are they young or old? Have you a tree in front of your house? If not, is there one on your neighbor's sidewalk?

Do Something

Do you think you could manage to give that tree a good drink twice a week, two or three pailfuls each time, letting it sink in slowly? Bring in as many answers as you can to these questions at the next meeting, and we will talk them over.

Number of Old Trees in Block . . .
Number of Young Trees in Block . .
Health . . . .
How many Trees Watered? . . . .
How many Times Watered? . . . .

What the Trees do for your Block

Learn Something

Watch the people on these hot days and see how they select the shady side of the street. In waiting for a car see them stand under the shade of a tree rather than in the hot sun. Notice the horse whose master leaves him in the heat creep up until he gets his head under the

grateful shade cast by the branches of the shade tree. Think how hot and sunny the house would be if that tall maple were cut down, which now brings coolness and shade to the front rooms! Many a sick person lies and watches the graceful swaying branches and restful green on the leaves.

Do You Know —

That a full-grown tree sends out 187 gallons of water a day through its leaves into the air? Think what a difference that makes in hot, dry weather.

That trees purify the atmosphere? The foliage takes in carbonic acid gas, which gas is deleterious to us, and gives out oxygen, which is healthful — indeed indispensable — to us?

That a tree in front of your house makes it cooler in summer and warmer in winter?

That it increases the value of property? A house with a tree in front of it sells for more than one without.

That half the people do not know these facts and do not appreciate them until some one speaks of them.

That you and I can help the City of   by knowing these facts, letting other people know them too, and lending a helping hand to the trees?

What to do Next

Cultivate

The roots of those trees of yours need a breath of air and a good square meal. Are they getting it? Down under the ground the roots are working busily enough, but they have a hard time. Help them by loosening up the soil around the base of the tree once a week. An ordinary garden trowel, spade, or a good sharp stick will do it. Then when you water the tree, the roots will have a better

chance to take in the liquid food from the soil and make a fine tree above ground.

Investigate

Find out a little about the health and happiness of your trees. Are there any invalids among them? Is there any poor tree that a horse tried to make a meal of? The next meeting of the League will be an experience meeting, when we will talk over what has happened to our trees. Here is a small list of possible tree accidents: —

Tree Injuries Easily Seen

1. Are there any of your trees with the leaves eaten away by insects?

. . . .

. . . .

2. Have any of them large holes showing decayed wood?

. . . .

. . . .

3. Have any of them dying branches due to telephone or telegraph wires?

. . . .

. . . .

4. Are there any tree trunks badly gnawed?

. . . .

. . . .

5. Are any of them being crowded by the sidewalk?

. . . .

. . . .

Agitate

Interest some of the people around you if you can. Tell them about your Club and what you are trying to do.

Let the other children in the block help you. Make friends for your tree. We can attend to the foes later.

"Trees are the handiwork of God —
We are banded together in their defence."

WEEKLY REPORT

............................Shade Tree Protectors.
From...............19.., to............19..
No. of trees watered.................
No. of times watered................
No. of trees cultivated...............
No. of violations reported............
Remarks.........................

....

Member's Name....................

Address....................

The above is an outline used by Mr. C. Bannwart, in his club work in Newark, N.J.

QUESTIONS

1. What are the uses of trees?
2. How do trees tend to regulate the flow of water?
3. What causes floods?
4. How should tree seeds longer than $\frac{1}{4}$ inch be treated? Shorter than $\frac{1}{4}$ inch?
5. Describe the steps in transplanting a young tree.
6. What care should be given permanent trees?

HOME STUDIES

1. What is meant by conservation of the tree supply?
2. What is being done by your state, by the United States, to conserve the trees? What are forest reserves?

3. Find out natural and artificial enemies of trees.

4. What do trees add to the value of land in your locality?

5. Can you name ten trees in your vicinity?

6. Make a list of the "deciduous" and the "evergreen" trees near the schoolhouse.

7. Why do some trees shed their leaves in winter?

8. Find out how much timber was cut last year.

9. What is the danger in letting a few men buy most of the timber land?

10. Visit a planing mill.

Free Bulletins

Insect Enemies of Shade Trees — Farmers' Bulletin No. 99.

Tree Planting on Rural School Grounds — Farmers' Bulletin No. 134.

Primer of Forestry — Farmers' Bulletin No. 173.

CHAPTER XXXI

THE ORIGIN OF SOIL

Exercises

1. After a rain storm dip a little water from a stream. Heat the water until it evaporates. Note what remains. Examine with a magnifying glass.

2. Heat a piece of hard clay until it is very hot. Add cold water. Press with the fingers. Note the condition of the clay.

3. Add a little hydrochloric acid to limestone or chalk. Note the "residue" which remains.

4. Grind up a piece of granite and other kinds of rock. Examine the particles with a lens and compare with the sand and the residue found in Exercises 1 and 3.

5. Find a marble that will just pass through a key ring. Heat the key ring red hot and try to pass the marble through the ring again. Dip the ring in cold water and try to pass the marble through the ring.

6. Heat a little sand which seems to be dry in a tumbler or test tube. Note the sides of the tumbler or test tube.

The earth each day tells part of its interesting story to those who will read from the winds, the rains, the rocks. Well diggers often encounter beds of rocks after drilling through many feet of loose earth. In the foothill regions this bed of rock is often brought to view after removing a few inches of soil. Sometimes

both in the foothills and the mountains the rocky bed has no covering at all. All of those facts tell one story — that thousands of years ago a crust harder than the material within, formed around the earth. For thousands of years the water, the ice, the winds, the plants,

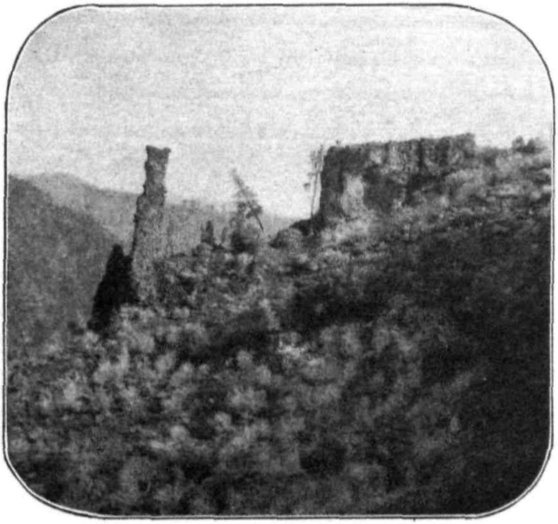


FIG. 143. — Nature's forces have partially cut away this mountain.

the changes in temperature, the animals, have been slowly breaking up this rocky covering to form, with the addition of humus and bacteria, what we call soil. This work is still going on. Each year tons of rocks are ground to help make soil.

How the rock is broken. After grinding up the piece

of granite in Exercise 4, if you had added decayed leaves and planted seeds, fairly good plants would have grown. With a piece of granite, a hammer, and decayed leaves it takes but a few minutes to make soil. Such soil is of low grade. Nature works more slowly. She is ages

FIG. 144. — A canyon made by a small river.

in preparing a seed bed. The forces of nature work unceasingly; lives of plants and animals are sacrificed by the thousands. Let us watch her at work on a mass of granite. The shining, scalelike bodies which you found through Exercise 4 were mica. The little quartz-like particles were hornblende and feldspar. Cold

causes bodies to shrink (Exercise 5). Heat causes them to expand, to increase in size. Hornblende, mica, and feldspar expand and contract differently. These substances in our mass of granite, or rock, when heated,

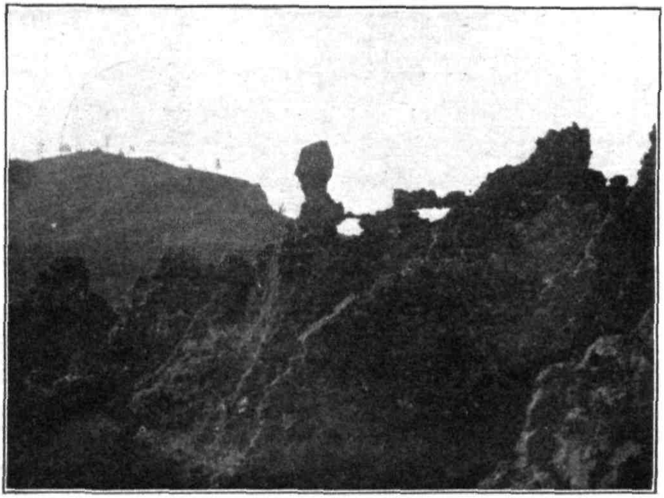


FIG. 145. — Nature at work building soil. The streams carry the crumbling rock to the valleys.

expand differently and, when cooled, contract in a different manner. Due to heat and its absence, the rock mass is twisted and wrenched slightly. Air and water enter. They mix and form carbonic acid. This acid attacks the softer particles of rock (Exercise 3) and the crevices are enlarged.

Water when freezing enlarges one eleventh in volume. The freezing water in the rock openings exerts great

pressure. Slowly the mass of granite is broken. Meanwhile the winds hurl particles of soil against the great rock, and the waters roll the larger particles, which are broken off, over and over and carry the finer

FIG. 146. — Trees help to break rock and to make soil.

particles to the valley (Exercise 1). In hundreds of years the softer parts of our mountain of granite are worn away. The rock is scattered over the valleys and but a few lonely crags remain to bid defiance to nature's forces. These in time will succumb. Thus nature brings the mountains of rock to the valleys. It remains for the sacrifice of plant and animal life to make the land fertile, to make what we call soil.

FIG. 147. — Stones worn round by running water. Another stream at work making soil.

QUESTIONS

1. How is it known that a crust of rock first covered the earth?

2. What is the work of water, ice, temperature, wind, plants, animals, air, etc., in making soil?

3. Of what is granite mostly composed?

4. How could you make soil of rock, humus, etc.?

5. What do sand and clay come from? What makes them fertile?

HOME STUDIES

1. How do gophers and earthworms help to make soil?

2. How may the roots of trees help to break up rock?

3. Explain the formation of crags and pillars of rock which stand alone.

4. How were the great underground caverns formed?

5. Where is the soil the deeper, in the foothills or in the valleys? Why?

6. Why are there so many rounded stones in a creek bed?

7. How is limestone formed? Chalk?

8. If the mountains are being carried to the valleys, will the surface of the earth be level some day?

9. Walk along a small stream and note where soil formation is going on.

10. Which part of soil is richer, the top or bottom layers? Why?

11. Why is there more "silt" found in the valleys than in the foothills? More humus?

12. How do you account for the different kinds of soils as to color and fertility?

13. What are residual, alluvial, and glacial soils?

14. Where do you think the soil came from which is in the school yard?

15. How was the Yosemite Valley formed?

16. Does this chapter deal with geography? Why?

CHAPTER XXXII

HOW TO GROW THE SWEETPEA

THE sweetpea is one of the most beautiful and fragrant of flowers. It lends grace to every occasion. There is no flower that responds more readily to careful treatment. Your garden is not complete without sweetpeas.

FIG. 148. — A prize winner.

In growing this plant, as in growing all other plants, use all the information that you have gained and that you can obtain in plant culture.

Preparation of the seed bed. Select a plot which is partly shaded during the day and which has a background, such as a fence, shrubbery, a shed, etc. The plot should be oblong in shape, about two feet wide, and

as long as desired. Sunlight will have its best effect if the plot lies north and south.

In the fall, work well-rotted barnyard manure and bone meal deep in the soil. If you desire extra fine

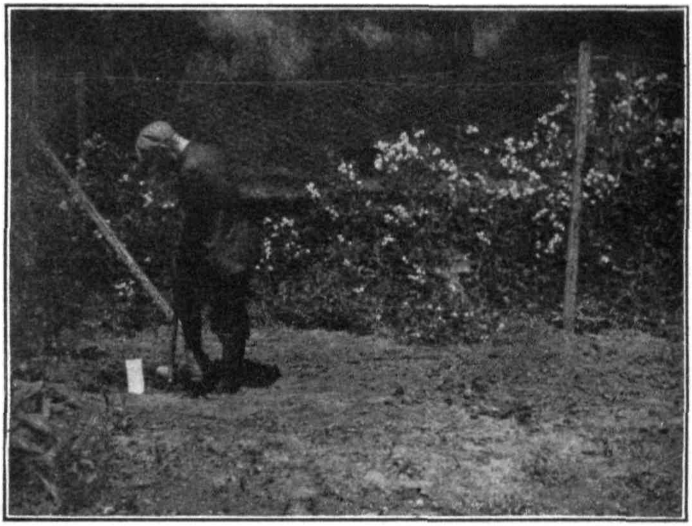


FIG. 149. — Subsoiling. The pile of soil at the right was removed from the hole in which the boy stands. He is stirring the subsoil.

flowers, spade the bed at least two blade lengths in depth. This may be done as follows: (1) dig a hole at one end of the plot the depth of one spade, and two feet long; (2) cart or carry this soil to the other end; (3) stir the subsoil thus uncovered another spade length; (4) add a few inches of sand or crushed rock to insure good drainage and follow with a thin layer of manure

or commercial fertilizer; (5) throw the following two feet of surface soil on the subsoil which was spaded but not removed; (6) break up the newly exposed subsoil, cover with the following top soil, and continue the process. Fill the hole at the end of the plot with the dirt which was first moved.

If you do not desire the *best* flowers, use the trench method of spading. Be sure to run the spade straight into the soil. Add a fertilizer as suggested above.

Sowing the seed. Sweetpeas like a soil which is not too light or too warm. The seeds do best if they are planted in November and December in California and in other states where the spring is early, although planting time may continue into May.

If the rains have not softened the proposed seed bed, the ground must be thoroughly sprinkled two or three days before working.

After making a careful selection from a seedman's catalog, secure the seeds and soak them *24 hours before sowing.* Dig a trench about five inches deep and sow the seeds about one inch apart. Cover with one inch of soil, pack the soil carefully, and leave the rest of the trench open.

Care of the young plants. As the young plants come up, thin to about one foot apart. The plants will not produce beautiful flowers if they are crowded. Add soil about the young plants gradually, until the trench is filled.

When the plants are large enough, furnish them with something to climb upon. Twigs stuck in the ground, a string frame, or a wire netting may be used. The frame should be at least five feet high.

After each rain, or irrigation with a hose, cultivate the soil with a hoe to the depth of two or three inches. Cultivate whenever a crust forms on the surface of the soil.

The plants at a height of two or three feet need much water. It is much better to dig a trench close to the row and irrigate thoroughly (see Chapter X) twice a week, than to sprinkle each evening. At this stage of growth, train to the netting any young plants that are out of position.

Care at the blooming period. The brilliancy and beauty of a flower depend upon healthy growth due to proper food conditions and to excellent care. Soak a sackful of cow manure in a tub of water. Add a quart of this liquid to six gallons of water, and apply close to the sweetpea row, but not on the vines, once or twice a week. Irrigate first with pure water. Pick the blossoms regularly. Do not let them go to seed. Long sprays of sweetpeas in glass bowls make an attractive display.

To keep insects, such as the red spider, away from the vines, spray now and then with the hose held close to the plant. This treatment will wash off unwelcome visitors. If the red spider should become too numerous, spray with whale oil soap or "black leaf," a tobacco preparation.

By plucking off many of the flower buds before they open, the food supply may be forced into the remaining blossoms, thus the plant may be made to grow extra fine flowers.

Sweetpea culture in pots, etc. Procure a few three-inch pots and fill nearly to the top with soil mixed as follows: $\frac{1}{3}$ leaf mold, $\frac{1}{3}$ sand, $\frac{1}{3}$ loam with a little bone meal. Plant three seeds separately in each pot one inch deep. Keep the soil moist, but not soaked. In the spring transplant as many as you please.

Kinds of sweetpeas. Seedmen group sweetpeas into four classes: (1) Early flowering; (2) Dwarf; (3) Grandiflora; (4) Spencer.

The early flowering class blossoms in about three months after seeding. Planted early in September, blossoms are ready at Thanksgiving and Christmas in warm climates.

Dwarf sweetpeas grow about eight inches high and spread widely over the ground. Rows planted a foot apart will become one mass of green foliage and brilliant colors. This type makes an excellent low border or ribbon bed.

The Grandiflora is the ordinary sweetpea which is so well known. The seeds of this class are quite inexpensive.

Gardeners who know, prefer the Spencer sweetpeas because of the rich colors, the size and beauty of the blossoms, the long sprays, the long blooming period.

SWEETPEA CONTEST

Often sweetpea growing contests are held in the schools. The following is a plan used in California:—

First — In order to enter the contest as an individual you must be a California Junior Gardener. It is only necessary, if you are not already enrolled, to send your name and address to the Chico State Normal School, Chico, asking to become a member.

Each school that contests shall be organized as a California Junior club. Write for information to the Extension Division Chico State Normal School.

Second — Contestants shall have no direct assistance in planting the seeds or caring for the plants further than that obtained from suggestions by friends or from reading. Each contestant shall do all of the work in growing the sweetpeas. He shall keep a diary, noting the following points: (1) Variety of seed planted and where obtained; (2) place and date of planting; (3) details of planting, preparation of soil, depth of sowing seeds, distance apart, etc.; (4) time young plants are first seen; (5) drawings of the young plants, two weeks and four weeks old; (6) care of the seedlings, cultivation, irrigation, etc.; (7) time of blossoming; (8) the signature of your teacher or another friend who knows of your sweetpea garden. This diary in a legible form shall be sent in with the twenty sprays of sweetpeas entered.

Third — prizes will be awarded from the following score card:—

	Points
For freshness and good color	4
For number of flowers of stem (four)	4
For length of stem (approximately 18 inches)	4
For arrangement of flowers on the stem	4
For size of bloom — approximate width of standard, $1\frac{3}{4}$; Spencers, $1\frac{1}{4}$; and others	4
For arrangement, neatness, punctuation, spelling of diary	5
Total	25

Fourth — Remember —

1. To buy good seed.
2. That "well begun is half done." Make the seed bed carefully.
3. To ask questions of florists, gardeners.
4. To read books on the growing of sweetpeas.
5. That prizes will probably be awarded on the 20 best sprays of sweetpeas, not on a greater number.
6. That it will be fun to join this big game and show the other children what you can do.

Fifth — The prizes are as follows: —

First prize for the best 20 sprays grown by a California Junior Gardening club	$10.00
Second prize	5.00
Third prize	2.50
First prize for the best 20 sprays grown by an individual California Junior Gardener	10.00
Second prize, a set of gardening tools	5.00
Third prize	2.50
The next 15 prize winners	1.00 each

Sixth — One or more of the following varieties must be grown: —

1. King Edward VII; red.
2. Dorothy Eckford; white.
3. Prima Donna; pink.
4. Lady Grisel Hamilton; lavender.
5. Miss Willmott; orange pink.
6. Hon. Mrs. E. Kenyon; primrose.
7. The Countess Spencer; giant pink.

Plant a few seeds every two weeks for four plantings, so as to be sure that blossoms are ready at the right time. Flowers grown in hothouses are not eligible.

Seventh — After the exhibit the flowers are sold: (1) To help pay the expenses of the exhibition and vegetable luncheon; (2) to further the Junior Gardening work.

Packing sweetpeas for exhibition. If they are carefully packed, sweetpeas will be little harmed after a twelve to fifteen hour journey. If you live near the place of exhibition, select the best type flowers, 20 or 30 sprays, and cut them the morning of the awards. Many flowers may have to be shipped some distance. Sweetpea blossoms should be *dry* when *packed*. Cut the sprays in the morning after the dew has dried up, or late in the afternoon. Cut the sprays at least two hours before packing. Place the peas lightly in water and set them in a dry, light place where the air is in motion (not in the sunlight nor in the dark).

Cut the sprays when the lower blossoms are well open and the top blossom half open, or when maturity is nearly reached. The stems should be woody, not "soft" and weak. Moisten cotton and wrap the ends of the stems and place the dried sprays in pasteboard boxes. (They may be obtained from florists, or a shoe box cut down will do.) If the weather is hot, line the boxes with waxed paper. This keeps the plant moisture from evaporating. Lay the sprays close together in rows, and cover each with tissue paper. Do not put too many sprays in a box for fear of bruising the flowers. Pack the box with tissue paper to keep the blossoms tightly in place.

Another very satisfactory method of shipping is shown in Fig. 149*b*. Place the stems in a test tube half full of water. Run paraffin around the stems.

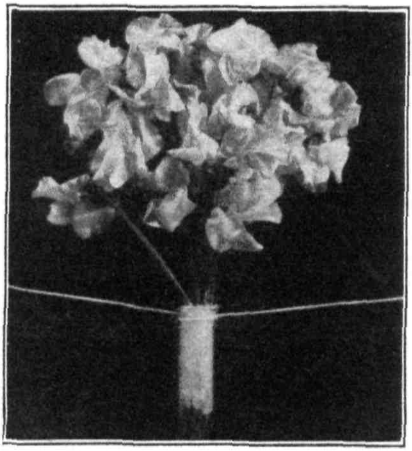


FIG. 149*b*. — These flowers were seventy-two hours in transit.

Pack carefully in cotton. Sweetpeas will stand a long journey if so arranged.

On arrival at the place of destination, place the sprays in clean, soft water at once, and arrange in attractive transparent glasses. In a short time the blossoms will awaken in their freshness and beauty.

If possible, go with your sprays to the exhibition so that you may arrange them artistically as to color and stems.

CHAPTER XXXIII

THE COW

THE farms must do more than feed the people with vegetables and cereals. They must "grow" animals to furnish meat, milk, etc., and must furnish animals to work for us. Again, it is quite necessary that alfalfa, wheat, corn, and many other crops which take plant food from the soil should be kept on the farm. If such crops are shipped away, in time the soil is robbed of its food. By keeping stock, much of the plant food is returned to the soil through manure. The wise farmer thus keeps his farm in balance. You have learned that by study and by care plants have been greatly improved for our needs; you have learned that by budding and grafting an almond seedling may be made to bear peaches; so farm animals, by study and care, may be improved. Let us study the cow, since she is of so much value to us all. By careful breeding two types of cattle have been produced — the dairy type to furnish milk, and the beef type to supply meat.

The dairy type. In general appearance this type of cow is wedge-shaped when seen from the side, the top, and the front. The skin is loose, medium thick,

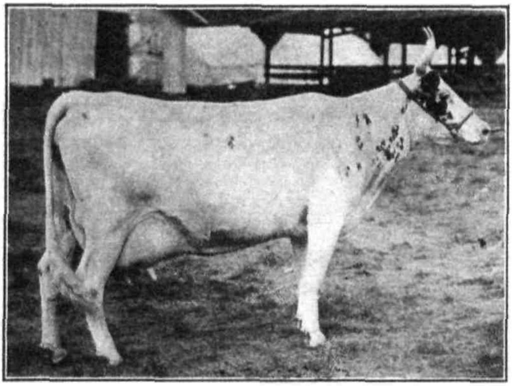


FIG. 150. — The dairy type.

and covered with fine silky hair. The bones are delicate, yet prominent. The ribs show quite plainly The chest is deep and low. The hips are far apart.

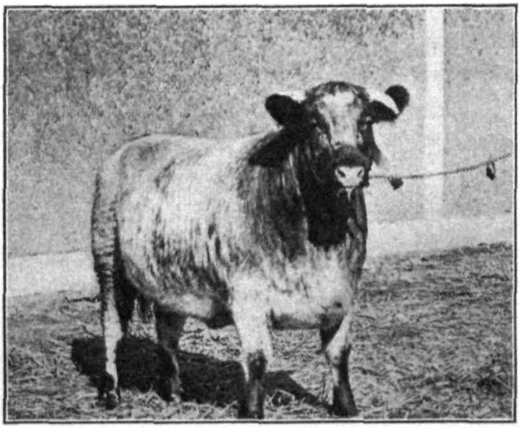


FIG. 151. — The beef type — front view.

The business of the dairy cow is to produce milk, hence the general appearance of the udder often indicates the value of a cow as a milk producer. In the best breeds the front part of the udder is carried full and well forward. It runs well up behind, is full and wide. The two milk veins, which may be felt just in front of the udder on the stomach, are large and much twisted. For more detailed description of the dairy type, see the score card.

The beef type. The top, rear, and side views of the beef type are rectangular (Figs. 151, 152, 153). The body is heavy and is supported on short, stalky legs. The legs are far apart, outlining a broad, deep chest and wide hips. The ribs do not show, since they are covered with flesh. The food has made flesh rather than milk. This type is described in detail in the score card.

Scrub cattle. Where breeding is not carefully carried on, mixed breeds of cattle often result. Many cattle have both the beef and the dairy characteristics. It always pays best to have the pure breeds. The dairy type produces far more milk than the scrub, and the beef type furnishes far more meat than does the mixed breed.

Dairying, when properly carried on, is one of the most profitable ways of farming. The profit or loss is determined by the quality of the cows. It has been estimated that a poor grade cow will return to the

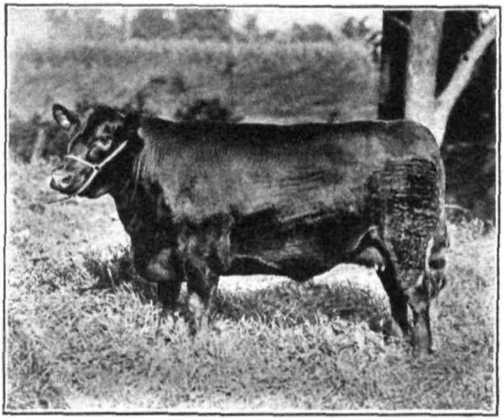


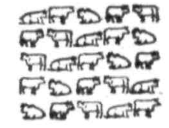
FIG. 152. — Side view of beef type.

dairyman but 77 cents in profit, while a high class Jersey will bring a net gain of about $31. Of course the best type of dairy stock is expensive at the outset,

FIG. 153. — A group on show — front and top view.

but can a dairyman afford to buy cheap cows which return him but 77 cents a head in profit?

"Twenty-five cows, each producing 301 pounds of butter fat per year, return profit of $783.



Twenty-five cows.

This is the average production of 139 cows comprising the best fourth of 554 cows in 36 Illinois dairy herds.

The lowest fourth (139 cows) of the same 36 herds averaged 133½ pounds of butter per year.

The picture on the next page shows exactly how many cows of the poor kind (1021) it takes to return identically the same profit ($783) as the above 25 good cows."

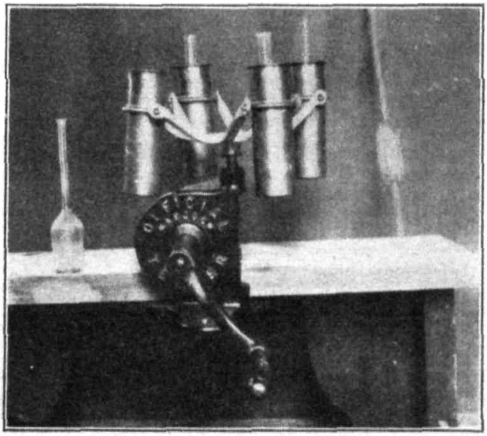
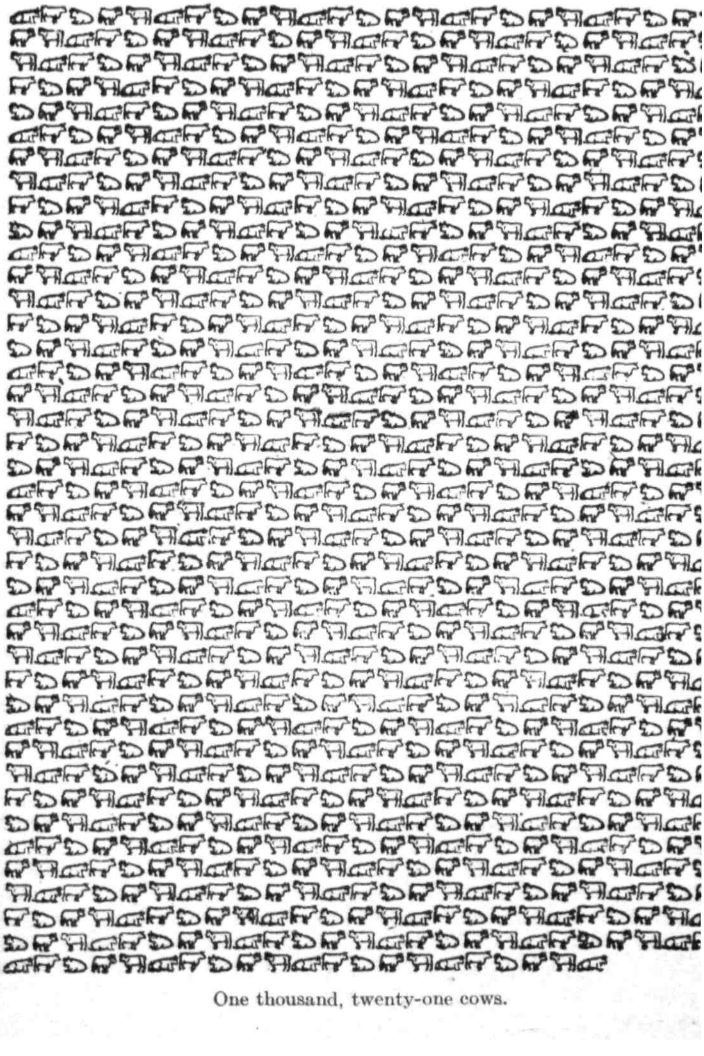


FIG. 154. — The Babcock tester. Test bottle at the left; pipette at the right. What the trap nest is to the poultry raiser, the Babcock tester is to the dairyman. It determines the cow's value as a butter-fat producer.



One thousand, twenty-one cows.

A SCORE CARD FOR JUDGING DAIRY CATTLE

Scale of Points	Female		
	Standard Score	Pupil's Score	Corrected Score
General Appearance: 16 Points			
Weight — Estimated ...... lb.; actual ..... lb.	1		
Form, wedge-shaped from front, side, top	7		
Quality, hair fine, silky; skin mellow, loose, medium thick, yellow, not fleshy; bone fine	8		
Head and Neck: 8 Points			
Muzzle, broad; nostrils, large	1		
Eyes, of good size, mild, bright	1		
Face, lean, fine, shapely	1		
Forehead, broad	2		
Ears, medium size, yellow inside, not coarse	1		
Neck, fine, rather long, well set on shoulders and head — top line slightly curved; throat clean; light dewlap	2		
Forequarters: 5 Points			
Withers, lean, thin	1		
Shoulders, light, oblique	2		
Legs, straight, short; shank fine, feet well placed	2		
Body: 24 Points			
Chest, deep, low; full; girth large	8		
Crops, not deeply depressed	1		
Ribs, long, broad, well sprung	5		
Back, lean, strong, well defined	2		
Barrel, deep, girth large	3		
Loin, broad, long level	4		
Flanks, low, deep from hip down	1		

A SCORE CARD FOR JUDGING DAIRY CATTLE
(Continued)

Scale of Points	Female		
	Standard Score	Pupil's Score	Corrected Score
Hindquarters: 13 Points			
Hips, wide apart	3		
Rumps, broad, level, long	3		
Pin Bones or Thurls, high, wide apart	1		
Thighs, thin, roomy, long, and well carried	3		
Legs, straight, short, wide apart, shank fine.	2		
Tail, long, fine, reaching hocks, good switch	1		
Udder or Rudimentaries: 34 Points			
Front udder, carried well forward, full, thick, soft, and mellow within, quarters even	12		
Hind udder, full in form, well up behind, good width, mellow, even .	10		
Milk Veins, large, long, elastic, tortuous			
Milk Wells, large	6		
Teats, 3 to 4 in. long, good size, well placed	2		
Rudimentaries, four, well placed . .	4		
Total	100		

NOTE. A defective teat or udder disqualifies. Females should weigh from 750 to 1400 lb.

SCORE CARD FOR BEEF CATTLE

Scale of Points	Perfect Score	Pupil's Score	Corrected Score
General Appearance: 38 Points			
Size and weight, score according to age. At 12 months, 850 lb.; at 30 months, 1500 lb.	6		
Form, top line and under line straight; broad, deep, low set, compact, neat paunch, stylish	10		
Quality, refinement as shown by clean, fine bone, mellow elastic hide, soft and silky hair	6		
Condition, degree of fatness as shown by fullness of cod flank, and tongue root and covering of ribs	8		
Fleshing, thickness, smoothness, and firmness of covering	8		
Head and Neck: 7 Points			
Muzzle, broad, mouth large, jaws wide, nostrils large	1		
Eyes, large, bright, placid, quiet expression	1		
Face, short, slightly dished	1		
Forehead, broad, full	1		
Ears, medium size, not coarse, well set	1		
Neck, thick, short, throat clean	2		
Forequarters: 9 Points			
Shoulder Veins, full and smooth	2		
Shoulders, well set, compact on top, nicely covered with flesh	3		
Brisket, advanced, wide	1		
Dewlap, skin not too loose, and drooping	1		
Legs, straight, short, arm full; shank fine, smooth	2		

SCORE CARD FOR BEEF CATTLE (*Continued*)

Scale of Points	Perfect Score	Pupil's Score	Corrected Score
Body: 31 Points			
Chest, full, deep, wide, girth large, foreribs full	5		
Ribs, long, well arched, thickly fleshed	8		
Back, broad, straight, smooth, thickly fleshed, even in covering .	8		
Loin, broad, thickly fleshed . . .	8		
Flanks, deep, full, even with under line	2		
Hindquarters: 15 Points			
Hips, moderately well set in, smoothly covered	1		
Rump, long, wide, even, not droopy, free of patchiness	4		
Thighs, thick, broad, full	4		
Twist, deep, plump	4		
Legs, well placed, short; hocks straight, shanks fine and smooth .	2		
Total Points	100		

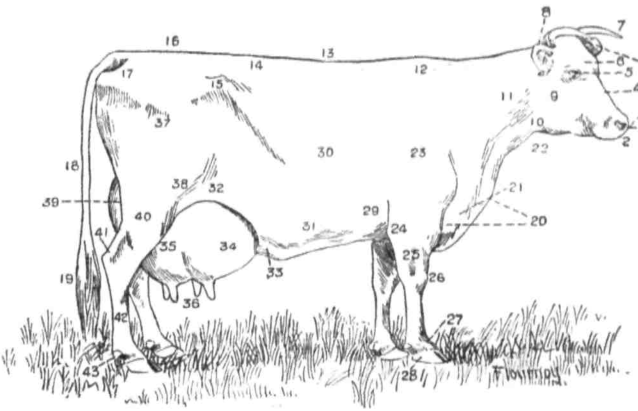


FIG. 155. — Points observed in judging dairy cattle.

1. Head
2. Muzzle
3. Nostril
4. Face
5. Eye
6. Forehead
7. Horn
8. Ear
9. Cheek
10. Throat
11. Neck
12. Withers
13. Back
14. Loins
15. Hip bone
16. Pelvic arch
17. Rump
18. Tail
19. Switch
20. Chest
21. Brisket
22. Dewlap
23. Shoulder
24. Elbow
25. Forearm
26. Knee
27. Ankle
28. Hoof
29. Heart girth
30. Side of barrel
31. Belly
32. Flank
33. Milk vein
34. Fore udder
35. Hind udder
36. Teats
37. Upper thigh
38. Stifle
39. Twist
40. Leg or gaskin
41. Hock
42. Shank
43. Dew claw

QUESTIONS

1. For what are the farms responsible?

2. Of what use is stock in making soil productive?

3. What are the two types of cattle?

4. Name the characteristics of the dairy type; the beef type.

5. What is meant by high-bred cattle? By scrub cattle?

HOME STUDIES

1. Learn the particular values of the following kinds of dairy cattle: Guernsey, Ayrshire, Holstein, Jersey.

2. What are the special characteristics of the following beef types: Shorthorn, Galloway, Hereford?

3. What types of cattle are raised by the farmers in your locality?

4. What is certified milk? Inspected milk?

5. Visit a certified dairy, if possible; a creamery.

6. How is milk shipped to the cities?

7. Where do house flies breed? Why are they so dangerous around a dairy? Are any methods used to keep them away from the milk?

8. Trace the ancestry of the dairy cow.

9. What is meant by domestication of animals?

FREE BULLETINS

The Feeding of Farm Animals — Farmers' Bulletin No. 22.
Sheep Feeding — Farmers' Bulletin No. 49.
The Dairy Herd — Farmers' Bulletin No. 55.
Breeds of Dairy Cattle — Farmers' Bulletin No. 106.
Care of Milk on the Farm — Farmers' Bulletin No. 63.

NOTE. The above score card is used in judging cattle in Ohio.

CHAPTER XXXIV

THE WEATHER[1]

Exercises

1. Close to the gardens erect a small structure to protect weather instruments from the weather (Fig. 156). A grocery box the right size will do.

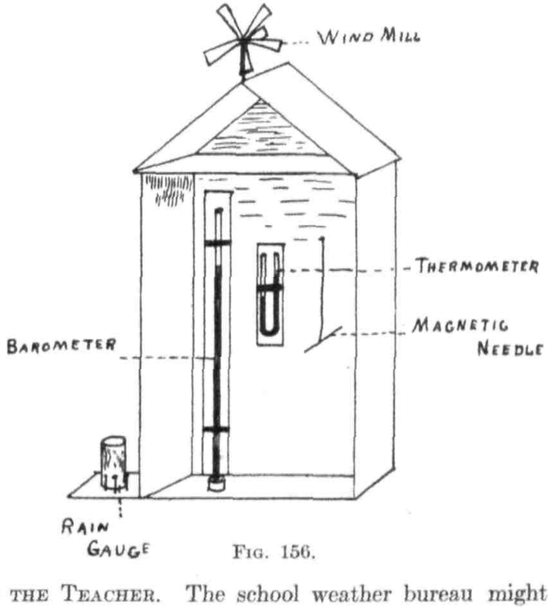


FIG. 156.

[1] TO THE TEACHER. The school weather bureau might serve well as a unit upon which to base a term's work in elementary science as a specific subject. The forces which work on the apparatus, heat, electricity, etc., might be studied in a unified way.

2. Make an anemometer, or wind gauge (Fig. 157): A = halves of celluloid or rubber balls; B = ribs of a broken

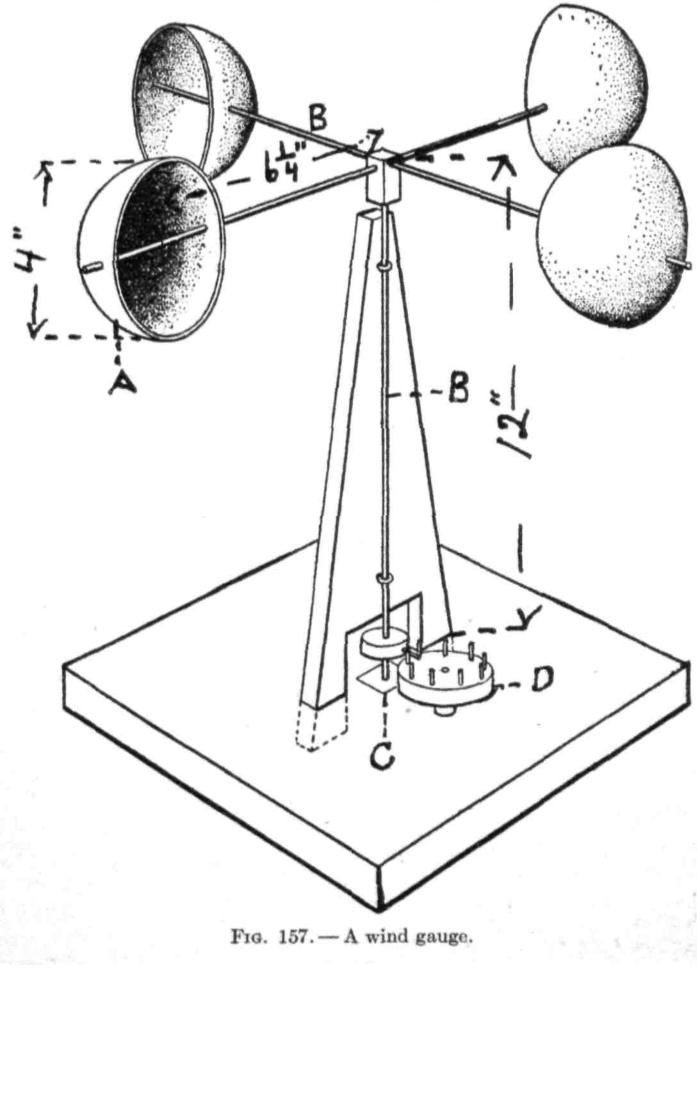


FIG. 157. — A wind gauge.

umbrella; C = small piece of glass; D = wooden disk pierced with small nails. Constructed properly, the number of revolutions of D in one minute will about equal the number of miles per hour that the wind is blowing. About 540 revolutions of the cups will measure a mile of wind. With a watch in hand, count the number of revolutions of the wheel (D) in a minute, and estimate the rate that the wind is blowing.

3. Make a photographic sunshine recorder and season indicator (Fig. 158). With a piece of pasteboard, partition

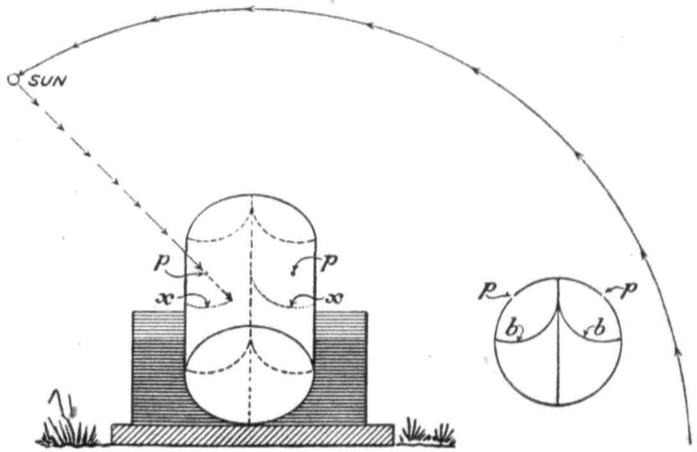


FIG. 158.

a 5- or 6-inch lard can lengthwise. Arrange pieces of blueprint as indicated at b. Make pinholes in the can (p). As the sun "crosses" the heavens, a line is made at x. Mark the date on the print and keep it. Each month use the same print again. Notice as the marks change in position that the seasons change.

4. Get a piece of glass tubing $\frac{3}{8}$ or $\frac{1}{2}$ inch in diameter. Seal one end by heating the tube. Fill the tube with mercury. Tip it up and down until the air is forced out. Fill the small dish (Fig. 156) half full of mercury. Place a finger over the open end of the tube of metal; invert it; insert finger and the end of the tube into the dish until they are under the surface of the mercury; carefully withdraw your finger. The column of mercury should be about 30 inches long. Place the tube against a piece of board. Graduate a piece of cardboard and place it so zero will mark the top of the mercury. Note the rise and fall of the mercury from day to day.

5. Rub a darning needle several times over a magnet. Suspend the needle with a piece of silk thread. Compare the direction it points with the needle of a compass. Hold the compass at some distance from the needle.

6. Obtain a maximum and minimum thermometer. Also an ordinary Centigrade thermometer.

7. Take the cover off of a baking powder can. Fasten the can in a place exposed to rains and snow, with nails driven close to but not through it. Measure the rainfall or snowfall as the opportunity is offered. (Use a piece of metal or a steel ruler.)

8. Make a windmill and fasten it to the top of the small house.

9. Place a brick and a pan of water in the sun. Test the comparative temperatures of each, using both hands. Which becomes the warmer in an hour's time? Which is affected the more by the sun? Make the same test at night.

10. Make a small paper windmill and hold over a stove. Note what happens. Strike a blackboard eraser over the stove. Note the action of the dust particles.

11. Moisten one finger with water or alcohol. What sensation is felt?

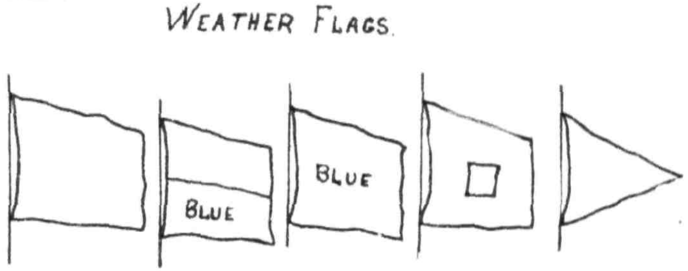


FIG. 159.

12. Make a series of signal flags, as shown in Fig. 159.

White flag indicates fair weather.

White and blue flag foretells local showers.

Blue flag indicates rain or snow.

White flag with black center indicates a cold wave.

The blue triangular flag placed above a weather pennant indicates rising temperature. If placed below it, means falling temperature.

13. Insert a Centigrade thermometer into the soil about six inches. In an hour take up the thermometer and note the temperature of the soil.

14. Make a hygrometer as illustrated in Fig. 160. As the thread *A* contracts and expands, due to varying amounts of moisture in the atmosphere, the lever *B* held loosely at *C* will swing up and down at *D*.

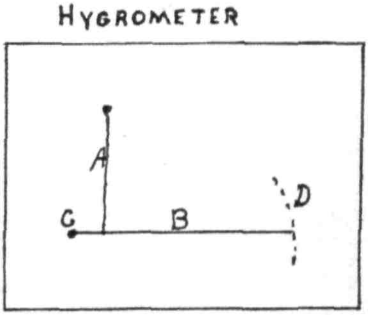


FIG. 160.

Put the following outline in your notebook and make daily records: —

WEATHER OBSERVATIONS

Date	Direction of Wind and Vel.	Rain or Snow in Inches	Clear or Cloudy, Storms	Kinds of Clouds	Temp. of Soils	Pressure of Air	Temp. Max. and Min.	Frost	Condition of Garden Vegetation	Remarks

A record like this for a month should illustrate the foregoing relations. You will find that a south wind, a falling barometer, dark heavy clouds, clouds moving in different directions, precede a storm. North winds, a rising barometer, etc., indicate clear weather.

A WEATHER BUREAU

Make but one set of apparatus for the class. After the material is ready, form a weather bureau. Write to the state weather observer for a set of observational weather blanks and ask that the daily weather chart be mailed.

Elect a weather observer whose duty it is to forecast the approaching changes in the weather. The forecasts should be posted daily. Use the flags. After understanding the relation of clouds, pressure of air, winds, etc., to changes in the weather,

and by using the daily weather chart, you will soon become quite expert in determining approaching changes.

Soon you will learn that the weather has a great deal to do with the success of your garden. You will learn that the frost kills beans, corn, and many other plants. Both crops can be saved by learning how to know of an approaching cold wave and by protecting the plants. The United States Agricultural Department, located at Washington, D.C., not only helps the farmer to grow his crop, but through the United States Weather Bureau system the Department helps him to make the best use of the weather. A careful set of records of temperature, rainfall, winds, crop production, and so on teaches the farmers when to prepare the soil, when to plant and harvest his crops. The Department, in announcing through the Weather Bureau system 24 to 36 hours ahead the approach of a cold wave, helps the farmer and the orchardist to save their crops.

The United States Weather Bureau. The United States government early saw the great benefit to be derived by the people if they could make use of the close relation of weather conditions to crops, so the United States Weather Bureau was established. The center of the organization is at Washington, D.C. There instruments are placed to record nature's forces. In most of the large cities, New Orleans, Boston, Denver, Chicago, San Francisco, and so on, there are located branch stations. At a stated time the regular observers

located in these cities make observations and telegraph them to Washington. Experts chart the reports and forecast the weather. The forecasts are telegraphed to about two thousand points, where by telephone, newspapers, etc., the farmers and orchardists are warned of approaching storms and frosts.

Coöperative observers. In order that certain local weather conditions may be studied, there are about 4000 coöperative observers who make observations without pay. The government furnishes them with a set of instruments, and each month a report is sent to the nearest main station. Possibly your school might be made a coöperative station by writing to this effect to the nearest government weather expert.

The work of the Bureau. Let us suppose that a severe cold wave is forecasted for northern California. The news is telegraphed along the Sacramento Valley to the distributing centers. By telegraph, telephone, and the newspapers, orchardists learn of impending frosts. By building fires in large pots a smudge is formed and the fruit may be saved.

Difference in climate. Climate is determined by the altitude, or height; by latitude, or distance north or south of the equator; by large bodies of water; by variable winds and by mountains.

You have learned (Chapter XXXI) that heat causes bodies to expand. Heat is the force which expands the mercury in the thermometer, causing the column to rise.

Now, the heat that influences climate is due to the sun. Heat, like light, may be reflected. One reason that the top of a mountain is cold is that the heat from the sun glances off the cone-shaped body (Fig. 161). Exercise 9 showed that water absorbs heat slowly and holds it long. Sun heat passes through the atmosphere,

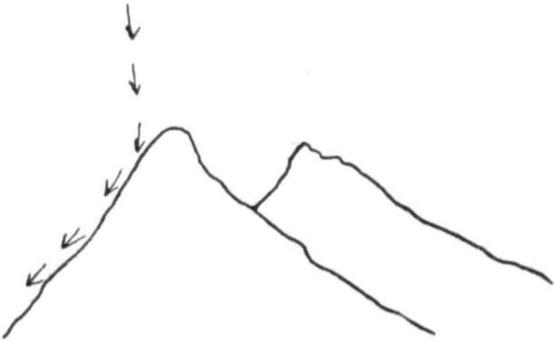


FIG. 161.

warming the invisible moisture. It strikes the earth, warming it. Much of the heat is reflected to the atmosphere where the moisture absorbs a part, another part is held close to the earth by gases (carbon dioxide), and the rest is lost in space. Each little particle of moisture in the atmosphere absorbs heat and then throws it off like a little stove. The carbon dioxide, like the glass in a greenhouse, holds the "dark" heat from escaping. It follows that wherever the air contains much moisture and gas, the temperature is com-

paratively high. The atmosphere at the mountain top contains little moisture, hence there is little heat absorbed, and less is given off. This is another reason for low temperature in the mountains. Also the air

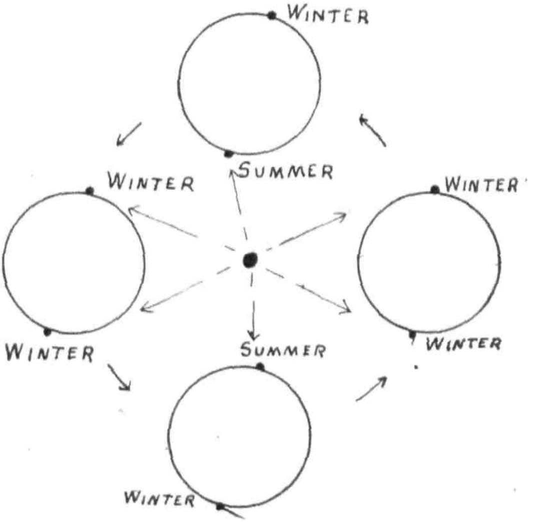


FIG. 162.

on the mountain top is very thin, so that reflected heat is lost in space.

In winter San Francisco is warmer than the interior cities. In summer it is cooler. This is true of other cities located near large bodies of water. It takes a long time to warm the ocean, hence it is colder in the summer than the land (Exercise 9). Exercise 9 showed

also that water warmed loses its heat slowly. Therefore, all winter the ocean warms near-by cities like a large stove.

A series of observations (Exercise 3) show that as the path of the sun across the sky approaches the horizon the cold weather begins. During the summer the path

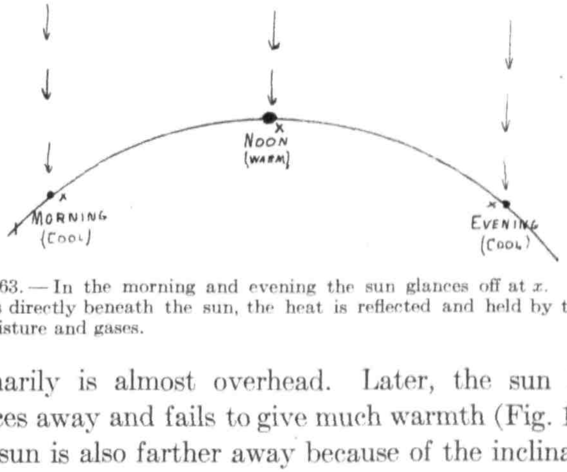


FIG. 163. — In the morning and evening the sun glances off at x. When x is directly beneath the sun, the heat is reflected and held by the air moisture and gases.

ordinarily is almost overhead. Later, the sun heat glances away and fails to give much warmth (Fig. 162). The sun is also farther away because of the inclination of the earth's axis. This is the main cause for the change of the seasons. The changes in temperature from morning until night are due mainly to one of the same causes, that of the sun heat glancing into space (Fig. 163).

Questions

1. Why do south winds usually bring storms?
2. What does a falling barometer indicate?
3. What are cirrus, cumulus, and nimbus clouds?
4. What soil temperature is best for plant growth?
5. Explain the working of the United States Weather Bureau.
6. How may frost in the orchard sometimes be prevented?
7. How do altitude, latitude, large bodies of water, and mountains affect climate?

Home Studies

1. Why is sunstroke uncommon in California? Think about Exercise 11.
2. How does a tubful of water in a cellar prevent vegetables from freezing?

CHAPTER XXXV

POTATOES

In the potato we have a plant with peculiar habits. The underground stems enlarge, forming the tubers, or potatoes. Since the tubers grow in the soil, deep mellow land suits them best. However, any soil not too clayey in nature, if thoroughly worked, will grow good potatoes.

Preparation of the seed bed. Apply your knowledge in forming a seed bed. Spade or plow about eight inches deep early in the spring, unless frosts are prevalent, and if two crops are desired, prepare the soil again in the middle of the summer. The more friable the land is, the better the potatoes will mature. A seed bed in which clover or alfalfa has been grown will produce fine potatoes, because of the nitrogen and the humus left in the soil.

Fertilization of the seed bed. Do not use fine wood ashes and fresh manure in a bed under preparation for potatoes, for they favor the development of "potato scab," a serious potato disease. Manure may be used if applied to the soil when another plant is grown in rotation. Use home-mixed commercial fertilizers. The following mixture is excellent on medium soils:

Nitrate of Soda, 25 lb.; Acid Phosphate, 50 lb.; Sulphate of Potash, 25 lb. Use about 10 lb. of the mixture to 10 square feet. After the furrows for the tubers

FIG. 164. — The potato harvest — 250 bushels to the acre.

have been made, spread on the fertilizer thinly; work into the soil and cover lightly. The potatoes must not touch the fertilizer directly. However, if the seed bed is thoroughly worked, there is little need of fertilization.

Selection and preparation of seed. The Early Rose and the Burbank are the best varieties to grow. If you are ambitious to grow the best potatoes, visit a successful potato grower and ask him to let you select

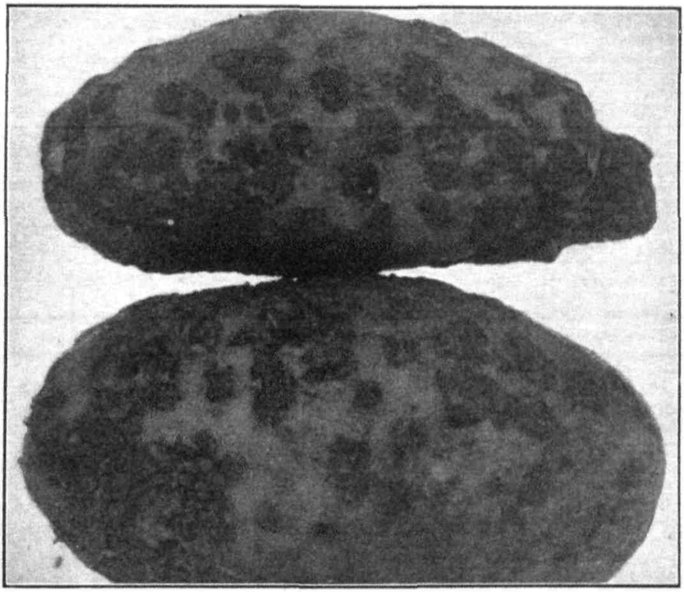


FIG. 165. — Potato scab.

your seed tubers from his field. Make your visit just before the potatoes mature. Select plants with a vigorous, healthy top growth; dig up the tubers. If they have the characteristics mentioned in the "Potato Score Card" given in this lesson, select the best, not

the largest. If the seed potatoes are purchased directly, be sure that they have not previously sprouted and the sprouts been broken off.

The germs which cause "potato scab" may be in the soil previously grown to potatoes, or carried on the tubers. To prevent "scab," wash the seed potatoes and then soak them for two hours in a formalin solution, $\frac{1}{2}$ pint of formalin to 15 gallons of water, or smaller amounts in proportion. Cut the potatoes in half lengthwise, and plant one to a hill soon before the sections dry out, or cut the halves in two crosswise, planting two sections to a hill. The pieces should weigh at least two ounces. Try both methods. Potatoes multiply through the "eyes." Cut the tubers so that each section has two "eyes" at least.

Planting. Make straight parallel trenches 4 or 5 inches deep, 3 feet apart. Work in the fertilizer, if it is to be used. Plant the potato sections from 10 to 14 inches apart, with the eyes up. Cover with two inches of soil. This insures warmth to the "seed." Fill the trench as you cultivate the young plants. Ordinarily the farmer cannot spare time for this trench method, but plants with a machine.

Care of the young plants. Potatoes respond readily to cultivation. Cultivate every 7 or 8 days to a depth of 2 inches. One potato grower increased his crop 41 bushels per acre by cultivating six times rather than three. With the seed sections planted 3 or 4 inches

deep, hilling is not necessary. It is well at the last cultivation, about blossoming time, to bank the plants slightly to prevent sunburn. By mulching his potato field with a few inches of straw, as the young plants came up, one potato grower increased his crop 50 per cent.

If irrigation is used, run the water in trenches between the rows. Do not let the water flood over, and do not apply too much.

Each hill of potatoes may be subirrigated by sinking a tall baking powder can with nail holes in the bottom near the potato sections. Keep the cans full of water and covered.

Harvesting. Dig the potatoes with a spading fork, using care not to bruise them. If they are to be kept any length of time, let them lie exposed in order that they may dry two or three hours before removing.

Improvement of potatoes. A successful potato grower will use such a plan as is outlined below to improve his potato crop: —

1. In digging his potatoes he will select from the hills with the most healthy, vigorous vines the best potatoes for seed to improve his yield of the following year.

2. He will put aside a plot of land for potato breeding. This he will lay off in rows as follows: One row will be planted to sections of potatoes taken from a selected hill, another row to another hill, and so on. Other best and most promising hills will be planted at the end

of the rows in the field outside the breeding plot. Each year this selection of superior hills in both places will continue until the whole field crop is greatly improved.

POTATO SCORE CARD

	Perfect Score
1. Size	4
Potatoes should be large and of uniform size.	
2. Shape	4
Tubers should be similar in shape and free from deformities and irregularities, neither too long or flattened.	
3. Skin	3
Skin should be firm, clean, bright, and clear, uniform in color; a white skin, other things being equal, is preferable.	
4. Soundness	3
Potatoes should be free from scab, rot, sunburn, and bruises; also from damage due to bad handling.	
5. Color	2
True to variety and fresh without sunburn.	
6. Flesh	4
A split potato should show no cavities, and should be firm in texture and free from dark spots and woody fiber.	
7. Eyes	4
Deep or sunken eyes, and those protruding in clusters, are objectionable, and cause a large loss in preparation for cooking.	
Estimated number of bushels to acre — greatest number of marketable value	10
	34

Potatoes for profit. In some Massachusetts towns from 250 to 450 bushels of potatoes are raised per acre at a cost of less than 30 cents per bushel. The average

yield in the United States is about 95 bushels per acre. Potatoes are a valuable crop. An acre of ground or less in potatoes well grown would keep your pocketbook well filled.

Potato disease and insect pests. If your potatoes are attacked by insects or become otherwise diseased, or if you wish to know more about potato growing, send for the bulletins listed below.

Home Studies

1. Visit a field which is producing potatoes. Do you find evidences of disease? What insect pests can you find? Study a means to get rid of the trouble.
2. How may the "potato bug" be controlled?
3. Are the potato growers trying to improve their crops? How?

Free Bulletins

Potato Culture — Farmers' Bulletin No. 35.

Potato Diseases and Treatment — Farmers' Bulletin No. 91.

CHAPTER XXXVI

HOW TO GROW CORN

UNDER favorable conditions corn gives a greater return to the gardener and to the farmer than any other cereal. It is the most valuable crop in the United States. Each year the soil produces over one billion dollars' worth of corn, and most of this wealth is taken from the soil of Iowa, Kansas, Illinois, Ohio, Nebraska, Missouri, and Indiana.

Not only is corn used as food for animals, and to make varnish, paper, pulp, corks, pipes, and fuel; but it is of great value when rotated with other crops. Many farmers realize its value for this purpose enough to grow corn, although there may be more profit in other grains. They have found that the total profit during a series of years is greater when corn is rotated with other plants such as barley, alfalfa, etc. Rotation with corn makes the seed bed deep and friable; it kills out the weeds; and when, after cutting, the corn stubble is plowed under, it adds humus to the soil.

GOOD VARIETIES OF CORN

Country Gentleman. — One of the best of late varieties. It has a fine flavor and is a sweet corn.

Stowell's Evergreen. — One of the sweet corns. It is an excellent all-round table variety.

Early Adam. — This is not a sweet corn. However, it can be used on the table as such. It is hardy and can be planted early.

Leaming. — This is the best yellow corn. It is an early variety. The stalks are leafy and make excellent fodder.

Fig. 166. — Sweet corn grown on a city school farm.

Sanford White Flint. — This is an excellent white corn.

White Rice Pop Corn. — This is the most popular variety.

There are many other varieties of corn. — Before planting, find the kind of corn that does best in your locality.

Selection of seed. Over 50,000 boys have been enrolled at one time in corn-growing contests organized in the "corn" states. Each boy was mailed instructions as to growing corn. The men in charge continually told the boys to select excellent seed. The average production of corn throughout the United States is 24 bushels to the acre. Many of the boys who entered the corn contest, by following instructions, raised 75 bushels to the acre, and one boy produced 228 bushels, winning the grand prize.

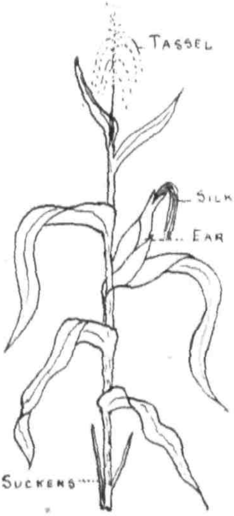


FIG. 167.

If you are to grow corn, grow the best corn in your vicinity. The first step in growing the *best* corn is careful selection of seed. Should the opportunity be given you to select your own corn in the field, or if you are to pick seed corn from your own garden, pick out a few of the largest and the most vigorous stalks. Select the large ears which bend downward. Remove the husks and select the ears nearest perfection, nearest like Fig. 167. The final test is the one of germination. Use the method as explained in Chapter VIII.

Preparation of the seed bed. Use all of the facts learned in making a seed bed for other plants,—deep

spading or plowing, from 8 to 12 inches deep, thorough fining of the soil. The success of the corn crop often depends on the preparation of an ideal seed bed. Prepare the seed bed early in the spring after the ground is warm and mellow.

If a fertilizer is used, stir in fresh barnyard manure, mixing it thoroughly with the soil. As has been said above, farmers have found that rotating corn and cowpeas, alfalfa, or clover has an excellent effect on corn production, increasing it many bushels to the acre. It is quite necessary to pay close attention to the little things in growing the best plants. The leguminous plants not only add nitrogen to the soil (Chapter XIX), but leave their roots in the ground to rot and thus add humus.

How to plant the seed, and when. After the mechanical nature of the seed bed is perfect, use one or more of the following methods in planting the seeds: (1) Hills 3 feet apart, 3 or 4 kernels to a hill; (2) hills 1 foot apart, 2 kernels to a hill; (3) hills 3 feet apart, 4 kernels spaced 5 inches apart in a hill. Plant all of the kernels 1 inch in the soil. The best time to plant corn is after the danger of frost is over, or about the middle of April in warm climates.

Care of the young plants. You have learned the reasons for careful cultivation (Chapter X.) If you wish an excellent corn crop, keep the hoe at work. Cultivate two or three inches deep as the surface of the soil shows

its need. Keep the base of the cornstalks free from suckers as well as the seed bed free from weeds. Corn that is planted early and cultivated often will seldom need irrigation. However, if water is added, use the trench method of irrigation (Chapter X). The plants need water most at the time of tasseling and earing.

Corn judging. Some day you may wish to enter a corn-growing contest. Certain varieties of corn, through careful seed selection, fertilization, and other advanced methods, have been greatly improved, until they have certain characteristics common to all; for example, a good Leaming ear is 10 to $10\frac{1}{2}$ inches long, slightly tapering in shape, 7 to $7\frac{1}{4}$ inches in circumference, kernels firm, deep yellow in color, medium rough indented, medium wedge-shaped and long. The butts, tips, etc., are well grown, and there are other points of perfection. See the scoring card, this chapter.

In selecting corn for seed or exhibition, after the ears have been picked arrange them in a pile with the butts towards you. Select the most perfect ear you can find, one which is most like the type. Now select those other ears which come nearest in characteristics to the one chosen until ten, or the required number, are selected.

In judging corn, a pupil's score card is used, such as is indicated on p. 293.

Corn breeding. One advanced method for improving corn is that of corn breeding. In Chapter XXIV you

learned how plants may be improved by artificial cross-pollination. This principle has been used in improving corn. If the pollen from a tassel (Fig. 167) which is a part of the male element of the flower should fall upon

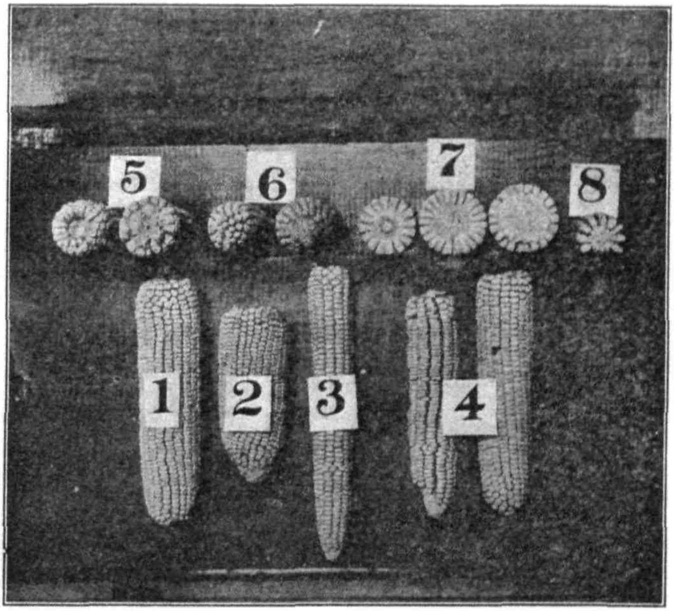


FIG. 168. — 1, 6, 7 are good types of corn.

a corn silk, a part of the female element, the result is a kernel of corn. See Chapter XXIV. Ordinarily there are as many corn silks as kernels on the ear. This would be an example of self-pollination, which is harmful to most plants. This is often prevented in the corn-

field by cutting off many of the tassels to insure pollination by some other stalk.

The best seed corn, selected from plants in which pollination or fertilization has been controlled, is sown. Again the best ears are picked for seed. In time the corn is improved many times. When our country becomes crowded with people, it will be necessary to grow more and better foodstuffs on a smaller area of land.

Home Studies

1. What is the life history of the corn "worms"? How does the corn grower get rid of them?
2. What is corn smut? What does the farmer do to prevent it?
3. How many bushels of corn to the acre are raised in your locality?
4. What does it cost to raise an acre of corn? If 75 bushels are grown on one acre, what might be the profit in growing 10 acres of corn?
5. Why does the farmer find it so hard to get men to harvest his crops?
6. What is there in corn which makes it an excellent food for animals?
7. Why is corn grown in your state? Why isn't more grown?

Free Bulletins

School Lessons on Corn — Farmers' Bulletin No. 409, Washington, D.C.

Observations on the Status of Corn Growing in California — Circular No. 70, University of California, Berkeley.

The Production of Good Seed Corn — Farmers' Bulletin No. 229.

SCORE CARD

PUPIL'S NAME

POINTS	PERFECT SCORE		PUPIL'S SCORE
TRUENESS TO TYPE AND BREED CHARACTERISTICS:			
1. Shape of ears: Cylindrical, straight rows, proportional length to circumference . .	10		
2. Length of ears, conformity to standard . .	5		
3. Circumference of ears, conformity to standard	5		
4. Color: (*a*) Grain, no mixed kernels . . .	5		
(*b*) Cob: White kernels, white cob; yellow kernels, red cob . . .	5		
5. Uniformity of kernels: Uniform size, shape, indentation	10		
		40	
GENERAL QUALITY, as related to yield, feeding value and vitality of seed:			
Proportion of corn to cob as indicated by:			
1. Butts of ears: Kernels swelled out about shank regularly	5		
2. Tips of ears: Filled out with regular-sized kernels	5		
3. Kernels: (*a*) Shape: Slightly wedge-shaped, straight edges	10		
(*b*) Depth: Deep or long . . .	10		
4. Spaces: (*a*) Furrow between rows	$2\frac{1}{2}$		
(*b*) Space between kernels at cob .	$2\frac{1}{2}$		
		35	
Composition and feeding value:			
Large germ and horny layer, and a relatively small amount of the white starchy portion	10		
		10	
Market condition and value for seed:			
1. Vitality: Bright, well matured, firm on cob, large bright germ	10		
2. Soundness or freedom from injury: No cracked, rotten, worm-eaten, or otherwise injured kernels	5		
		15	
Total		100	

REVIEW QUESTIONS ON LESSONS XXX TO XXXVI INCLUSIVE

1. Of what use are trees?
2. What are forest reserves?
3. What is the danger in having the forests owned by a few men?
4. How is soil being made?
5. Which part of soil is the richer? The top or bottom layers?
6. What is the great responsibility of the farms?
7. Why is it cheaper to have high-bred stock on the farm?
8. What is certified milk?
9. Where do house flies breed? How are they harmful?
10. What is meant by subsoiling land? What is gained?
11. How does the United States Weather Bureau system help plant growers?
12. How has man made use of nature's forces, — heat, light, electricity, air, etc.?
13. What are the characteristics of a good potato?
14. How may corn be improved?

CHAPTER XXXVII

POULTRY AND PIGEON RAISING

PROBABLY so much of your time is taken up with school work and games and food comes so easily to you, that you seldom think of its source. It is not a great task to feed one family, but it is a problem to feed a million families. We must thank the cow for our milk, butter, cheese, and much of our meat. We must thank the lowly hen for meat and eggs. In one year the hens produce in eggs and poultry $600,000,000 worth. At the present writing there are over 275,000,000 chickens on the farms, valued at $155,000,000.

Chicken breeds. Chickens, because of certain characteristics, are divided into four classes: (1) egg breeds, — such as Minorcas, leghorns; (2) meat breeds, — such as Brahmas, Cochins; (3) general purpose breeds, — such as Plymouth Rocks, Wyandottes, Rhode Island Reds; (4) fancy breeds, — such as bantams.

Selecting the flock. While many poultry enthusiasts raise fancy stock for pleasure alone, the ordinary questions in selecting breeds are, Do the hens do their work well? Do they produce eggs and meat? Experience has proved that the Barred Plymouth Rock and the Wyandottes are the best all-round breeds.

Due to improper care, many chickens are of small size. They lack breadth and depth of body; the legs are thin; the breast is shallow. Select the active, large, well-built "pure-breeds."

The home for chickens. It is said that the ancestors of our chickens were the fowl which ran wild in the jungles of Asia. The "wild" tendency is often seen in the roosting of hens in trees, beneath shelters of leaves and mistletoe. In making a home for the fowl you should make it as near like the wild home as possible. This means a sandy, well-drained, well-ventilated (not windy), sunshiny spot, with plenty of room for the hens to run about, and with plenty of green food convenient.

A good poultry house. A human being shut in a close room soon suffers for want of moving air. This is doubly true of a hen, for, according to her weight, she needs twice as much fresh air as does a man. A poultry house must be well ventilated. The *best part* of one *whole side* must be left open (Fig. 169). See, however, that there are no drafts. During stormy weather, the opening may be closed, temporarily, with canvas. Each fowl requires at least 2 square feet of floor space. A house 7 × 10′ does very well for 25 hens.

The farmers' bulletins which are listed at the end of this chapter will tell you how to arrange the interior of your building as to nests, perches, etc. When the hen ran wild, she selected nesting places and food as she saw fit. Now the care of the hen rests with us. We must

see that she is housed properly; that she is fed properly; that she is given plenty of opportunity for exercise; that the house and yard are kept perfectly drained and cleaned.

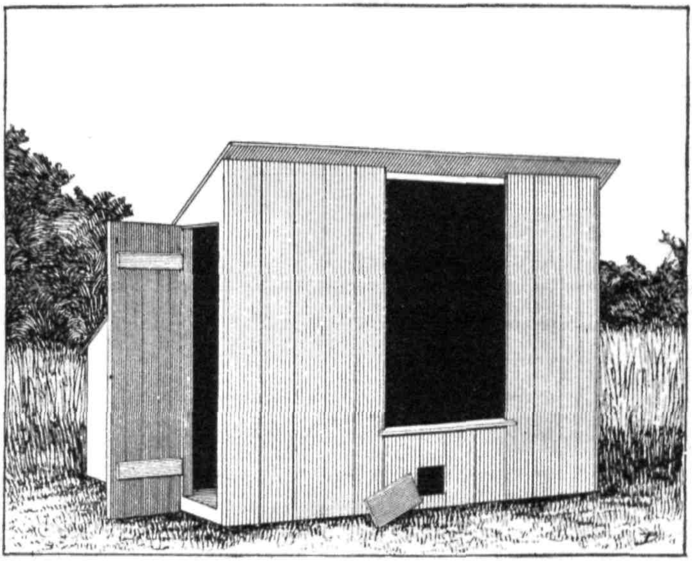


FIG. 169.

Feeding the hen. Food is taken into our stomach and remade to build tissue. This is true of the food given to the hen. However, in the case of the hen there is an additional use for the food. After the needs of the body have been satisfied, the surplus food is used in making eggs. Therefore, a hen must be carefully

fed in order that she may be a profitable animal. A good hen will lay about 150 eggs a year. Just as a poor grade dairy cow lowers the productiveness of a herd, so a number of low grade hens lower the efficiency of a flock. Through the use of the "trap nest" (Figs. 170, 171), the poultry raiser may weed out the poor

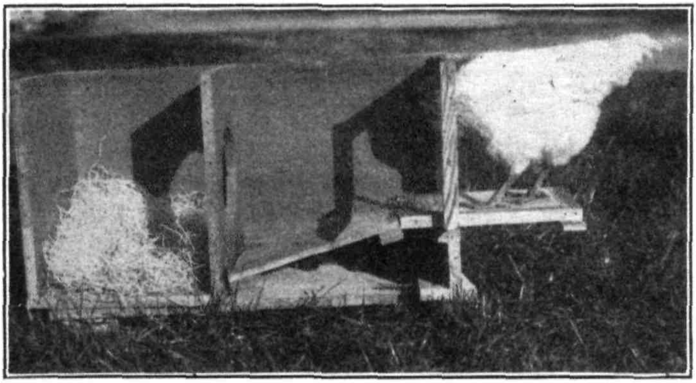


FIG. 170. — This hen pays her way.

layers. The trap nest has done more to make chicken raising profitable than anything else, for it tells whether a hen is a good layer or not.

In feeding laying hens there are two things to be considered: (1) variety of food, and (2) the method of feeding. The ration must include grains, animal and vegetable foods, and eggshell material. Wheat and corn do very well for grain foods, while fresh meat scraps, milk, worms, and insects will furnish the animal matter.

During the open months the hens will usually find enough animal matter on the range, but when housed up they should be fed meat scraps, etc., liberally. Green food is necessary and should be fed each day. Alfalfa, clovers, chard, sugar beets, grass, etc., will do very well.

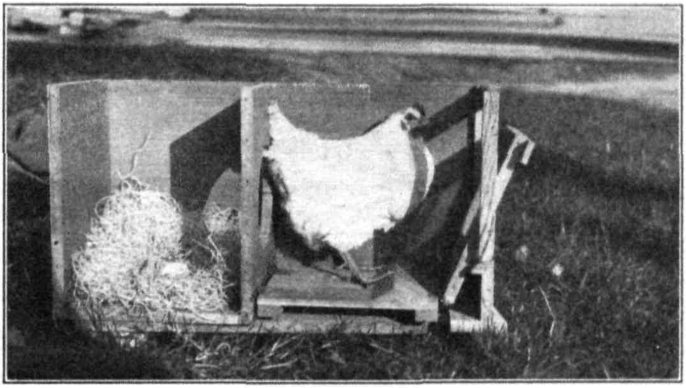


Fig. 171. — Her work performed.

Lime or eggshell material should be a part of the hen's diet. Oyster and sea shells ground up, with sand particles which the hen finds herself, furnish lime for forming eggshells. This material should be kept where the hens can get it at any time. Many poultrymen feed charcoal and salt to help the hen's digestive system.

A lazy hen is a poor egg layer. A hen should be kept busy scratching. Throw the grain into a litter of straw

some six or eight inches deep. Leghorns do not need as much exercise as the larger breeds. Ground food is more easily digested than whole. About $\frac{1}{3}$ of the grain matter should be made into wet mash and fed late in the afternoon, to be followed by wheat or corn just before roosting time. It is hardly necessary to speak of cleanliness in feeding and in the general care of hens. Remember to feed a variety of wholesome food regularly and liberally in such a way as to keep the hens active. Of course, the hens must have access to fresh water at all times.

Brooding chickens. Because of the added expense, in incubating chickens artificially, and the additional amount of time and care necessary, poultry contests

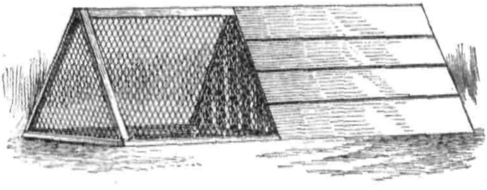


FIG. 172. — A good brood house.

should consider only the natural method of brooding. If the hen that wishes to "set" is active and shows signs of vitality, — neck short and stout, back broad, breast round and full, body deep and broad, — you should select for her fresh eggs of some pure breed. You should make the nest in a box 14 × 14 × 6″. This box should be filled with earth to within two inches of

the top, and lined with straw, then placed near the ground in a quiet place. It is best to keep a "setting" hen in a coop by herself. With wire netting and a grocery box, a combination brood house and a small run way should be made. In such a coop the only care is feeding and watering the hen. Otherwise the hen if in a closed box should be let off her nest once a day to obtain food and drink and to dust herself. She should be dusted now and then with sulphur to keep her free from small insects.

When the chicks are all hatched, move the combination coop to a clean, sandy spot. Place a safety drinking fountain where both the hen and the chicks may reach it. Also throw in a few rolled oats and a little bread soaked in milk. In a few days feed the necessary material: grain, animal food, and green matter.

FIG. 173. — Fruit jar upside down.

Improvement of the flock. (1) After vigorous purebreed hens have been selected, set only high-class eggs; (2) keep the chicken house clean and open; (3) eliminate the inactive hens, those poor in vitality, the nonlayers (use the trap nest), and the chickens more than two years old; (4) keep only pure breeds, both hens and cocks.

Rules to Govern a Poultry-raising Contest

1. Age of contestant shall be limited to boys and girls between 10 and 18 years.
2. Each contestant shall care for at least 5 chickens.
3. Each boy and girl shall keep a record of the food consumed.
4. The contest shall last one year.

SCORE CARD

Records well kept	20 Points
Good housing	15 Points
Yard arrangement	10 Points
General cleanliness	10 Points
Increase of flock (natural incubation)	10 Points
Condition of the flock	15 Points
Methods in feeding	10 Points
Practical ration	10 Points
	100

Free Bulletins

Poultry as Food — Farmers' Bulletin No. 182.

Incubation and Incubators — Farmers' Bulletin No. 236.

Poultry Management — Farmers' Bulletin No. 287.

A Successful Poultry and Dairy Farm — Farmers' Bulletin No. 355.

Standard Varieties of Chickens — Farmers' Bulletin No. 51.

PIGEONS

To many people pigeons are more interesting than chickens. They are easily tamed, and they make excellent pets. By calling the birds with a whistle at feeding time, they soon learn to respond. With a little

patience they may be taught to feed from your hand and to light on your head or shoulders.

Pigeons are so beautiful and refined that they are far superior to chickens as pets. Much of the time of a pair of pigeons is devoted to love-making and the rearing of

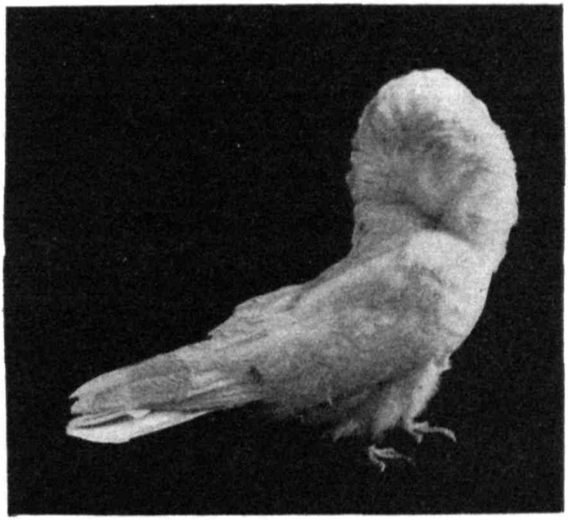


FIG. 174. — White Jacobus.

young. In their originality, they are ever offering some interesting activity.

Pigeon breeds. A pigeon fancier has a great range of choice in selecting his birds. To enjoy really a " loft " or a " fly " of pigeons, get as many varieties as you can. The figures show the most interesting birds. Figure 174

illustrates one of the "ruffle-necks." Sometimes the head is almost hidden by the soft muffler of feathers. The "fantails" have a remarkable development of tail feathers. These often touch the head that is held so proudly. Then there is the "tumbler" which flies high in the air to turn somersault after somersault only to catch himself before reaching the ground. The "pouter" often struts about with his crop so distended with air that he can hardly walk, much less fly.

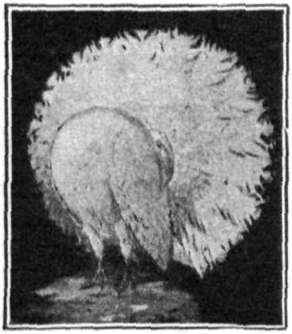


FIG. 175. — Fantail.

Housing pigeons. A cote may be made in the loft of a barn with a half dozen exits. If such a plan is followed, the birds fly at large. A landing place of laths and shelf should be fastened just beneath the openings to the cote. It is a good plan to keep new birds shut up in the cote several days before they are allowed to fly. Otherwise they may leave. Handle and feed

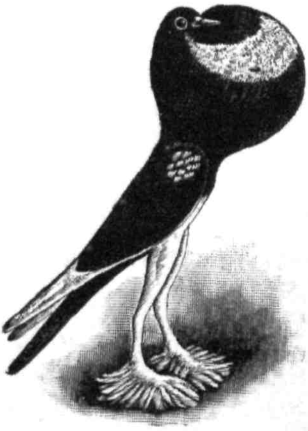


FIG. 176. — English pouter.

the new birds carefully during their captivity to insure their return when liberated. Pigeons at large are more interesting than those kept in captivity. In a short time they may be trained to come from high in the air at the call of a whistle.

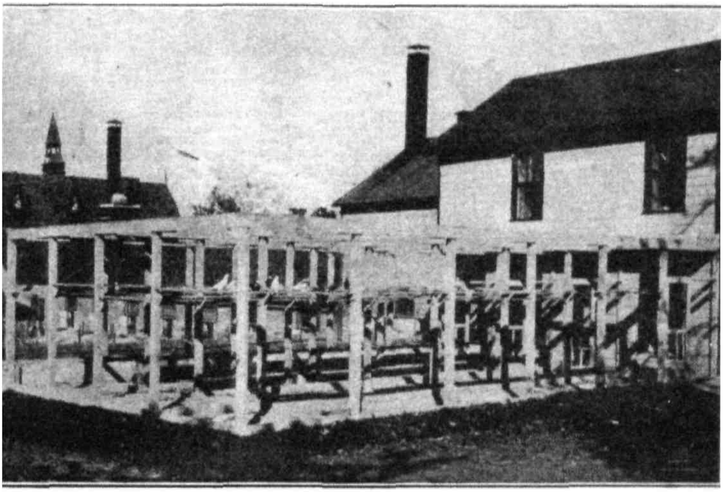


FIG. 177. — Pigeon house and flies, Department of Experimental Breeding, at University of Wisconsin.

To prevent loss of valuable birds or to meet a city ordinance, however, pigeons are often housed as shown in Fig. 177.

General care of pigeons. All of the suggestions relative to the health and activities of the hen are applicable to pigeons. In all cases the cotes should be kept clean. Sand on the floor will help to accomplish this.

Nesting of pigeons. After mating, the female birds lay two eggs at an interval of two or three days. A row of nests should be made in the bird house. Both birds incubate the eggs. In about seventeen days the eggs hatch. For nearly a month the "squabs" are fed by "regurgitated" food from the parents' crops. Even when the young pigeons have learned to fly they are often, after much squealing and commotion, fed by the parents.

A pigeon-raising contest. The rules and score card dealing with the raising of chickens may be applied to pigeons.

CHAPTER XXXVIII

COTTON

Cotton is grown extensively in the United States. It is the principal product of eight states and one of the most valuable money crops in the whole country. A great deal has been accomplished in the general improvement of fruits, flowers, and vegetables, by seed selection and crossing, but little had been done until the last few years, comparatively speaking, to improve cotton, yet it has responded and is responding generously to careful treatment.

Needs of the cotton plant. Plants, like people, have their likes and dislikes. The cotton plant, particularly, is affected readily by climatic and moisture conditions. The conditions must be such that the plant has a long, warm, if not hot, growing period of at least six months; the amount of moisture in the soil must be constant, growing less, however, as the plant nears maturity; the temperature must be even. Let us see how these needs may be satisfied.

Soil. Man has no control over climate beyond his ability to choose that which suits his needs best. Therefore, the cotton planter should locate in a place enjoying a long, hot growing period. The second need of the

cotton plant can be satisfied, in a measure, by partial control of soil and moisture conditions. You have learned that a sandy soil loses water rapidly and that it hurries the growth of a plant. It does very well for vegetables, but it would not grow a good crop of cotton, with the exception of the Sea Island variety, which thrives in a 75–90 per cent sandy soil. You have learned that a clayey soil holds water long, that it tends to produce growth of stalk and leaves as a general thing. A clayey soil is adapted to wheat, grass, and alfalfa, but should be avoided by the cotton grower.

"A deep loam naturally well drained, sufficiently retentive of moisture to maintain a uniform supply of moisture," satisfies best the needs of the cotton plant.

Water and soil relations. The Imperial Valley in California produces abundant crops not only because of fertile land, but also because of the control of water conditions. There is little rain, yet there is water for irrigation purposes. Water may be run on to the field as the plants need it. Where water conditions cannot be controlled as in irrigation, it is necessary to handle the soil properly.

Preparation of the seed bed. The land should be plowed 5 to 8 inches deep after the first rains in the fall or spring in order to catch all the water that falls. To insure a good crop, cross plow and harrow thoroughly just before the seeds are planted. To make a warm seed bed, to give proper drainage, and to prevent root

pruning when cultivating, the land should be ridged every 4 feet, giving a wavy effect. The ridges should be from 2 to 3 inches high and kept compacted. In some sections cotton is planted on flat ground.

Seed selection. If the sugar content of sugar beets can be raised from 8 to 18 per cent through seed selection, the cotton crop can be greatly improved through the same process. If cotton is grown in your vicinity, find out what variety does best. Do not be in a hurry to buy your seed. Write to the nearest experimental Station, or to the Secretary of Agriculture, Washington, D.C., for information as to the best source for the seed desired.

Having obtained your seed, give it the germination test. If the percentage of germination is high, plant it thickly, $\frac{1}{4}$ to $\frac{1}{2}$ bushel to the acre in the ridges about one inch deep. Plant late in March or early in April.

Care of the young plants. As soon as the young plants come up, begin to thin them out until they are a distance of from 10 to 20 inches apart.

In order to keep out weeds and to conserve the moisture, cultivate shallowly once a week.

Harvesting. Pick the cotton when the bolls are well open, and pick it quickly, for the color soon changes and the bolls gather sand and dust particles.

If you live near a cotton ginning mill, have your crop ginned after it has matured in storage.

Improvement of crop. The test of a successful

farmer is his ability to produce large and profitable crops and at the same time to build up the fertility of the soil. The cotton grower should practice fertiliza-tion and crop rotation. He should select seed for his new crop from the best plants in the old.

Rules for Contestants

1. Boys and girls between the ages 12 to 18 shall be allowed to contest, either as individuals or as a club.
2. At least ¼ of an acre shall be planted to cotton.
3. A record shall be kept of cultural methods.

SCORE CARD

Good record keeping	15 Points
Large bolled	15 Points
Length of staple	25 Points
Twist of staple	20 Points
Color	5 Points
Production (number of mature bolls to plant, and number of plants to acre)	20 Points

Free Bulletins

The Cotton Plant — Farmers' Bulletin No. 33.
Sea Island Cotton — Farmers' Bulletin No. 302.

CHAPTER XXXIX

SUGAR BEETS

CALIFORNIA was the first state in this country to grow sugar beets. During the last few years from 1888 to 1910, the production has grown from 1,910 to 144,747 tons in the state mentioned. The beet-sugar production in the whole United States for 1910 was 498,400 tons. This industry bids fair to become a leading one.

Needs of the sugar beet. You have learned that one function of leaves is to produce sugar under the influence of sunshine, therefore in order to raise beets containing a high percentage of sugar a great deal of sunshine is necessary. For best growth the sugar beet also needs warmth, but not excessive heat, a long tap root, abundant soil food, and plenty of water. Let us see how to satisfy these needs best.

Soil. A deep, rich, sandy loam is the best soil for sugar beets, for such a soil helps to insure a vigorous root system (Fig. 178), retention of moisture, and warmth. However, beets will do well in soils which are not too clayey or too sandy and which have been worked previously with other crops. Sugar beets often do well in soil too alkali in nature for other plants.

Preparation of the seed bed. As in growing other

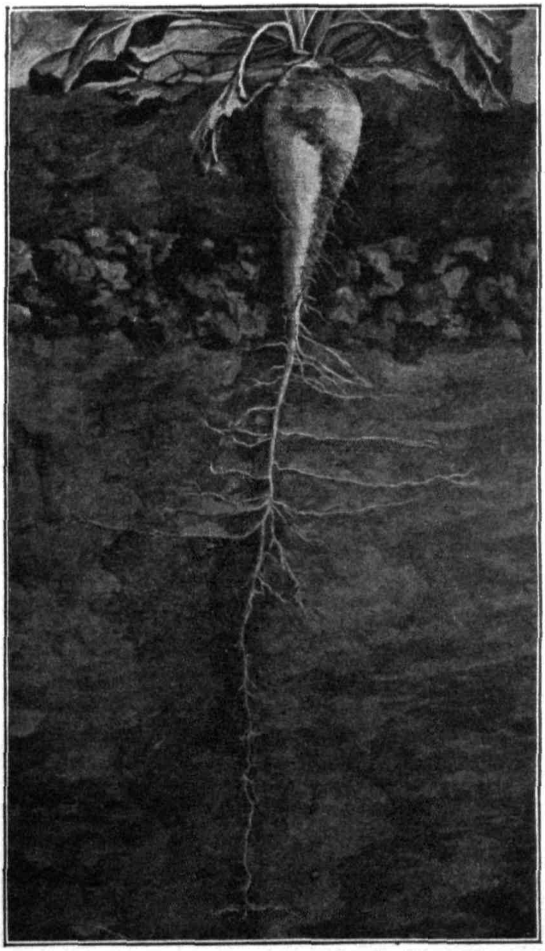


FIG. 178. — Showing root system of sugar beets.

plants, the first step essential to a successful sugar beet crop is a well-prepared seed bed. The soil should be deeply plowed, 10 to 18 inches, if possible, and thoroughly harrowed.

Selection of seed. The sugar content of sugar beets has been increased to 18 per cent through selecting seeds from the best producing plants. The second step to attain a successful crop of any kind as well as one of sugar beets is to plant *best* seeds only. They may be obtained from a reliable seed company or a successful grower of beets.

Seed planting. Plant the seeds about one and one half inches deep directly after harrowing, and, while the soil is moist, in rows 18 to 20 inches apart about 18 seeds to a foot or 18 to 20 lb. to an acre. Sugar beet seeds need a compact seed bed. After sowing, pack with a board or roll the rows unless you have undertaken to grow the plants in a clayey soil which tends to cake.

If climatic conditions permit, plant the seeds as early as February. Follow this suggestion particularly in states where the summers are hot, with little rainfall.

Two classes of beets are grown, one long, tapering, with a small top, used in open, well-drained lands, and the other shorter, blocky, with a large top, used in wet, poorly drained, or heavy lands. Select the beet which fits best your soil.

Irrigation. In states where the average rainfall does not reach 18 inches and in states without rain at intervals during the months of sugar beet growth, irrigation should be practiced. You have learned that surface irrigation tends to prevent deep root growth. This root growth is essential to the production of a good sugar beet, therefore irrigation should not be practiced while the plant is forming its root system. Later, if the leaves are drooping in the evening, and have not freshened by morning, irrigate, using the trench system. Delay the first irrigation as long as possible. Cultivate soon after irrigation. Irrigation should be continued only until the plants begin to mature, so that after that time all the plant's energy may be devoted to making sugar. Ordinarily two to four irrigations will suffice.

One very important condition in successful farming is the proper relation between moisture and soil. The sugar beet responds very quickly to care which insures a seed bed uniformly moist. Often it is far better to flood the intended seed bed just before plowing and seeding than to apply water after the plants are up. In order to flood the plot, raise a slight embankment and turn in the water. Such treatment, followed by thorough and persistent cultivation, is better, under ordinary conditions, than regular irrigation.

Care of the young plants. Thin out the weak plants *early* to a distance of 6 to 10 inches. Cultivate the

beets often to conserve the moisture, to prevent weed growth, and to aërate the soil.

In growing sugar beets, as in growing other plants, you must study their needs and apply the principles of

FIG. 179. — The little things count.

plant growth that you have learned. It is the little thing that often determines how a plant is to grow. Figure 179 shows how the little things count. The sunflowers apparently were treated alike, but note the difference in growth. This might have been due to

(1) poor and good seed, (2) cloddy and fine soil, (3) a slight difference in soil food, (4) different depths in planting the seeds, (5) some seeds being close in contact with soil on all sides, others not, (6) the presence of different weeds, (7) a slight difference in the amount of soil water, (8) a difference in cultivation, (9) different amounts of sunshine, etc.

Rotation. Sugar beets are vigorous feeders, hence fertilization and crop rotation should be practiced. Rotate alfalfa, potatoes, and grain with the beets.

Harvesting. If you have entered a sugar beet growing contest, do not let your beets dry out before they are shipped to the place where the awards are to be made. A few of the beets should be sent to the nearest sugar beet factory so that the sugar content may be determined.

Rules for Contestants [1]

1. The contest shall be limited to boys and girls from 10 to 18 years of age, working as individuals or in groups.
2. At least $\frac{1}{4}$ acre of sugar beets shall be grown.
3. A record of the beet culture shall be kept.
4. The percentage of sugar content shall be determined in the average beet.

[1] The plan for carrying on a sweetpea growing contest (Chapter XXXII) will be suggestive as to details for governing this and other contests.

SCORE CARD

Good record keeping	30 Points
Sugar content of 20 average beets, at least 12 per cent .	40 Points
Nearest to type (Fig. 178):	
Weight 1 to 2 lb. Good shape	10 Points
Free of extra roots	10 Points
Springy texture, juicy, tender	10 Points

Free Bulletins

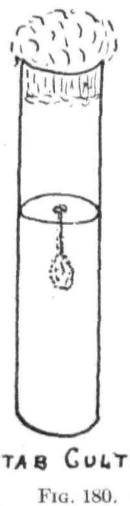
The Sugar Beet — Farmers' Bulletin No. 52.
Irrigation of Sugar Beets — Farmers' Bulletin No. 392.

CHAPTER XL

PUBLIC HEALTH

Exercises

1. Ask your teacher to make a gelatin culture medium for petri dishes, test tubes, and flat-sided bottles, or, better, make it yourself. To an eight-ounce bottle three fourths full of water add two tablespoonfuls of ordinary cooking gelatin and a drop or two of strained honey. Place the bottle in boiling water until all solids are in solution. Add with a stirring rod just enough ammonia to make the solution turn red litmus paper blue very slowly.



STAB CULTURE

Fig. 180.

Sterilize test tubes, bottles, petri dishes, etc., which are to hold the cultures. A sterilizer may be made cheaply as follows: Place in the bottom of an ordinary tin pail, wire netting with the corners bent down so as to raise the netting two or three inches from the bottom. Add water to the depth of one and one half to two inches. Place the apparatus to be sterilized on this netting in the pail, cover and set over a flame. Sterilize for thirty minutes. Pour the gelatin into the test tubes, etc., and sterilize. To be absolutely sure of pure cultures, sterilize for thirty minutes on three different days. Let the culture

medium cool. Sterilize a knitting needle or a hairpin by holding over a flame, rub across the teeth, remove the cotton plug of a tube, stab quickly into the test tube containing the gelatin medium, withdraw and plug again with cotton (Fig. 180). In a similar manner make "stab" cultures from the drinking water, samples of milk, the finger nails, from different places on the skin, from lead pencils and the many other instruments that are put into the mouth.

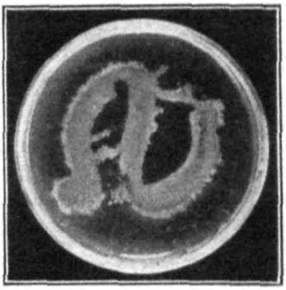


FIG. 181. — The path of a finger across a petri dish marked by bacteria.

Press the lips to a gelatin medium in a petri dish, cover and set aside. Touch the fingers to a similar preparation, wash the fingers, and again touch a gelatin preparation (Fig. 181).

2. Prepare four stab cultures of milk or water. Place one in a cool place, one in a high temperature, one in the sun, and in one mix in a little formaldehyde before the medium hardens. Note results.

3. Prepare two flat-sided bottles with gelatin culture medium. Catch a house fly and let it walk over the culture medium in one. Observe results each day.

4. Expose a petri plate for two minutes before school and another after school; before dry sweeping and dusting, and after. Watch the developments each day.

5. Rinse out a milk bottle which was used the day before. Cork it tightly. Twenty-four hours later note the odor due to the bacteria which remained.

6. Keep two bottles of milk in the schoolroom, one containing certified milk. Which sours the more quickly? Why?

7. Boil two pints of water. To one add a little tobacco solution (boil an ounce of tobacco in ½ pint of water). Place a tadpole in the tobacco solution and one in the pint of pure water. Note the effect of the tobacco on the tadpole.

8. Try the same experiment, using alcohol in the place of the tobacco.

9. Place a small amount of kerosene on the surface of a tumbler of water containing several mosquito larvæ (wrigglers). Note results.

10. Place a "boat" of mosquito eggs in a tumbler half full of water, and cover with mosquito netting. Make drawings of each stage in the development of the insects.

11. Make a drawing of a mosquito egg as seen through a microscope.

12. Place a few wrigglers and a tadpole or fish in a jar. Note results.

THERE are at least 3,000,000 persons on the sick list to-day in the United States. About 500,000 of these have tuberculosis. Many thousands of these sick people are unable to move about, while thousands of others are only partially kept from their work, yet all are inefficient to a greater or less degree. A man cannot do his task well if he has a bad cold, a sick headache, tonsillitis, indigestion, or some other "minor ailment." Witness how disagreeable you felt, how hard it was to study, during your last illness. Most sickness is due to minor ailments. They not only levy a tax of unhappiness upon mankind, but it is estimated that they cost at the lowest figure one billion dollars a year.

Minor ailments are preventable. We are told that nine tenths of the minor ailments are preventable. If you could prevent another attack of headache, sore throat, indigestion, or a cold, would you not gladly do so? Let us see what can be done. It is easy to blame others for your sickness. However, in most cases no one is to blame but yourself. You alone are responsible. Let us see how this is true.

Kinds of sickness. There are two classes of disease: (1) communicable, such as typhoid fever, diphtheria, malaria, and colds, because apparently healthy people acquire them by coming near the sick, or the germs are carried by animals such as the mosquito and the house fly; (2) non-communicable, such as headache and diabetes. A great many more deaths are caused by communicable diseases than by those that are non-communicable. Therefore most sickness results from tiny plants (bacteria) and animals (protozoa) called germs, which enter the body through the mouth, nose, or wounds, and grow if conditions are ripe for development. Such conditions are the result of improper living, overeating, use of tobacco and alcohol (Exercises 7 and 8), lack of sleep and exercise, or anything which tends to weaken the system. The secret of health is to live so well that the germs which enter the body and cause sickness may be eliminated before harm is done.

How germs enter the body. Exercises 1 and 4 show that bacteria are ever present in the air, particularly

in the air of a poorly ventilated room. If certain specific bacteria are breathed in and they locate in lungs weakened by a cold or improper living, they may cause pneumonia. Another kind may cause consumption. Sickness is often prevalent after a windy period because of the bacteria that are blowing about. Witness the many people with colds after a few windy, dry days. Sunshine kills bacteria (Exercise 2), therefore you should let sunshine into the house, and you should spend much time out of doors.

Each individual has two responsibilities, (1) one to himself, (2) one to his neighbor, hence you have no right to neglect a cold, for your carelessness not only makes you unhappy, but it endangers your neighbor, for colds are communicable. A patient with tuberculosis, typhoid fever, or diphtheria is an incubator for millions and millions of bacteria. He is very dangerous to his neighbor. Each time a consumptive spits he liberates millions of bacteria which on entering other weakened lungs may cause disease. We are told that one who has had typhoid fever may carry typhoid germs for one month, six years, or for life. Thus he may be dangerous to a community, for the bacteria are liberated with the body's excretions. Both the germs of tuberculosis and typhoid fever, besides those of many other diseases, may be carried by the house fly (Exercise 3), which flies from the gutter, cuspidor, or outbuildings into the house only

to walk over the meat and potatoes or to fall into the milk.

Each day a stream of millions of germs enters your body through the nose and the mouth. While all of these organisms are not harmful, there are many which may cause disease. If your health is good, your body will usually *rid itself of the "pathogenic" germs.*

Prevention of sickness. Each case of sickness strains your body and makes it less efficient in fighting another disease. If for no other reason than this, you should try to prevent sickness. Sickness may be prevented more easily than cured. Since a large majority of diseases is due to the stream of germs which enters the body through the nose and mouth, in order to prevent sickness, (1) this invading host must be reduced in numbers, and (2) the general health must be built up so as to resist those that enter.

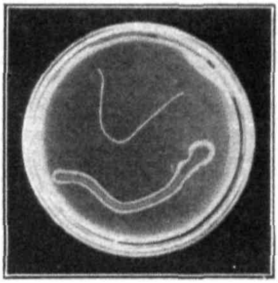


FIG. 182. — Note the bacterial colonies on the thread which was not boiled.

Bacteria are parasitic plants, therefore their growth is favored by moisture, "dirt" or filth, and warmth. Thus it readily follows that lack of moisture, filth (Exercise 5), and warmth as well as the presence of bright sunshine, great heat (Exercise 1) (boiling water, etc.), disinfectants (formalin), and antiseptics, retard the de-

velopment of bacteria. The number of bacteria, then, may be decreased in foods by boiling, sterilizing, cooking, and by keeping in a cool place shut away from insects, particularly the house fly. Milk and water are excellent media for bacteria and are very easily contaminated, yet we drink them both without ever questioning their cleanliness. Ninety thousand bacteria have been found in one drop of milk. They may be harmless, yet their presence shows that the conditions are excellent for containing harmful bacteria. Such a bacterial count tells a story of dirty cows, dirty hands, unclean pails, dust, and house flies. A hair falling from the cow into the pail often carries as many as 1000 bacteria, a particle of dirt may add several thousand more, dirty hands and flying dust particles add their thousands, and the house, or typhoid, fly brings its millions. When it is known that one bacterium in milk at summer heat increases to nearly 1,000,000,000 in 24 hours, should we not be careful of our milk supply?

Questions

1. What do minor ailments cost?
2. Who is responsible for most sickness?
3. What is meant by a communicable disease?
4. How do disease germs enter the body?
5. What two responsibilities has each individual?
6. How may much sickness be prevented?
7. Why should the milk and the water supply be carefully inspected?

Home Studies

1. What is the death rate in your community? Is it high or low? How do you account for its highness or its lowness?

2. What was the average age of "life expectancy" 100 years ago and now? How do you account for your answer?

3. What is meant by "eugenics"? Public health? Personal hygiene? School hygiene?

4. Make a table showing how many of the boys and girls in your room were sick the past month. How many days of absence were due to sickness?

5. Visit the source of your water and milk supply.

6. What is your individual health score? See the score card which follows.

PERSONAL HYGIENE SCORE CARD

Sleeping in the open, screened from insects	5½
Bedroom windows open	3
Light bed clothing: Eiderdown comforter, etc.	2
Hair mattress	1
Small pillow	1
Bed clothing aired each day	2
Linen changed once a week	2
Rise regularly at seven	4
Light exercise	3
Cold bath	5
Care of hair	2
Teeth cleaned twice a day	4
Individual towel	2
Glass of cold water	2
Mental hygiene: sing, play	3
Hygienic breakfast	4
Verse from Bible	1

Flowers on table	1
Clean dishes and attractive table	1
Fruit, cereal, eggs, bacon	1
No drink, unless milk	1
Rest 20 minutes	2
Walk to school or work briskly	1½
Carry books at arm's length	1
In school	
Best possible light	2
One and one half hours for lunch period	2½
Hygienic lunch	4
Carbohydrates (bread, fruit, vegetables)	
Proteids (vegetables, meat)	
Attractive table	
Cheerful conversation	
Chew food thoroughly	
Eat moderately	
Rest 20 minutes	1½
Walk briskly to work or school	1½
Two glasses of water during afternoon	2
Vigorous exercise (tennis, baseball, etc.)	3
Rest 20 minutes before dinner	2
Hygienic dinner, 5–6	4
Soup / Bread	
Fish / Rice, custard, bread pudding	
Meat / Milk	
Vegetables / Good combinations of these	
Potato	
Rest 20 minutes	2
Sing, play, read orally	2½
Study or work one hour	2
Softened electric light	2
Light exercise	2½
Retire regularly at 9.30	5
Two nights for play to 10.30 or	
One night to 11.30	

Glass of water before retiring	$1\frac{1}{2}$
Cleanse hands, face, and mouth before retiring	1
At least one hot bath a week	$\frac{1}{2}$
Keep finger nails clean	$\frac{1}{2}$
Hygienic clothing	$1\frac{1}{2}$
Correct posture	$1\frac{1}{2}$
	100

Bulletins

Write to your city or to your State Board of Health for copies of bulletins on health.

Write to the Washington Government Printing Office for the bulletin, "National Vitality, Its Wastes and Conservation," by Irving Fisher.

Meats: Composition and Cooking—Farmers' Bulletin No. 34.

Facts about Milk—Farmers' Bulletin No. 42.

Sewage Disposal on the Farm—Farmers' Bulletin No. 43.

Milk as a Food—Farmers' Bulletin No. 74.

How Insects Affect Health in Rural Districts—Farmers' Bulletin No. 155.

To the Teacher. It isn't what the pupil, the student, the scholar, knows; it is what he can do that counts.

The child is the starting place of anything that educates him, and to educate him he must do this thing. To this end the above score card for a hygienic day should be used in scoring the children each week. Each pupil should have a card, and each day he should score himself. On Monday mornings the averages for the week should be entered in the teacher's class book. The week's average should count one half toward the student's grade.

CHAPTER XLI

THE MOSQUITO AND THE HOUSE FLY

INSECTS have certain rights which we may regard so long as they do not interfere with the development of the higher animals. Each plant and each animal has within it a mysterious driving power which is bringing about perfection. Anything which interferes with this driving power for good must suffer. The mosquito and the house fly in their familiarity and their germ-bearing possibilities interfere with our happiness as much if not more than any other animals.

Malaria — its cause. Malaria is an insidious disease. It causes but few deaths, comparatively speaking, yet thousands of people drag about low in efficiency because of the malarial germ.

Malaria is due to a minute animal (protozoan) which enters the human blood through the proboscis of a certain type of mosquito (which has bitten a malarial patient), the anopheles. The germ at once enters a red blood corpuscle. Here it feeds on the red coloring matter and multiplies until the corpuscle bursts, liberating in the blood the animals and their excretions. The new germs seek new corpuscles, and the process is repeated. The "chill" usually takes place with

the bursting of the corpuscles. This circle is repeated over and over. Thus new life is made without the

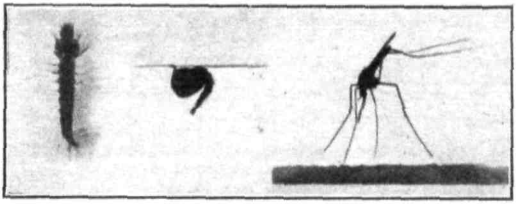


FIG. 183. — Larva, pupa, and adult of culex mosquito.

union of a male and a female nucleus. However, the malarial protozoan would be eliminated entirely from nature were it not for the appearance at intervals of male and female organisms in the human blood. At this period, if the patient is bitten by an anopheles mosquito, the nuclei of the female and the male bodies unite in the stomach of the mosquito. The minute animals which result from the union bore through the stomach and work up to the salivary glands of the mos-

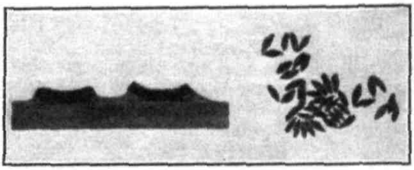


FIG. 184. — Eggs of culex mosquito on the left. Anopheles eggs on the right.

FIG. 185. — Larvæ of anopheles and culex mosquito. Anopheles at left.

quito. From these glands they may be injected into the blood of the next human being that is bitten.

FIG. 186. — Adult mosquitoes. Anopheles at the left.

Life history of mosquitoes. The female "culex" (the variety seen commonly) mosquito lays from 250

FIG. 187. — Marking a mosquito breeding place.

to 400 eggs on the surface of standing water. In a few days the wrigglers (larvæ) hatch. They float or wriggle down to feed at the bottom of the pond. At intervals the larvæ wriggle to the surface for air (Fig.

FIG. 188. — A boy pointing out larvæ of the anopheles mosquito.

185). Soon the insects pass into the pupa stage. The pupæ float at the surface and later split along the back. The young mosquito, using its cast-off skin as a boat, dries itself and flies away.

How to prevent malaria. Three factors are necessary for the production of malaria: (1) a person to be in-

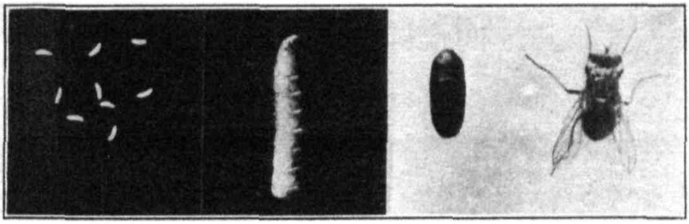
fected, (2) an anopheles mosquito, (3) a person infected with malarial germs. The mosquito which transmits the disease may be eliminated: (1) by removing its breeding place — drain the pond; (2) by covering the pond with oil, thus shutting off the air supply; (3) by keeping fish and tadpoles in standing water; (4) by cutting away vines and shrubs with heavy foliage. Thus it is within the power of any community to prevent the spread of malaria. Figures 187 and 188 show school children helping to rid a community of mosquitoes. The children marked the breeding places with a flag. Later these ponds were drained or covered with oil by men employed by the city.

The House Fly

The house fly has no nicety as to its haunts. It hurries from outbuildings to garbage cans and gutters, apparently enjoying most the worst of filth. The uncleanly habits of the house fly would worry us little were it not for its absolute lack of respect for a human being. In its familiarity it walks over the table food, with its mouth-parts and feet covered with disease germs and filth, swims in the milk, and even lights on one's nose or lips or on the baby's rubber nipple.

Life history of the house fly. Figure 189 illustrates the stages in the development of a house fly. The female lays from 75 to 125 eggs in horse manure or in a garbage pile. In a season she lays from 2 to 4 such

batches of eggs. The fermentation taking place in manure produces a warm place in which the eggs hatch in from 12 to 24 hours. The larvæ, or "maggots," feed for a few days only to enter on the pupa stage from which the adults develop. The life history cycle is completed under good conditions in 12 to 14 days. Ninety-five per cent of the house flies breed in the offal from the barn. It has been estimated that one pound



Eggs. Larva. Pupa. Adult.

Fig. 189.

of manure may produce 1000 flies in 12 days. Many cities have offered prizes to the boys and girls who could kill the most flies. One boy during 20 days caught 484,000 house flies. This method of controlling the house flies works very well if in addition the breeding places are removed. A little arithmetic teaches you how futile the effort is to control the house fly by killing the adults, if the breeding places are ignored. The ordinary manure pile weighs about 1000 pounds. Multiply this by 1000, the number of flies which may breed in one pound. The result is 1,000,000. In most

communities there are hundreds of piles. Each female fly hatched, in a few days, may lay from 75 to 125 eggs. While a boy might catch 484,000 flies in 20 days, millions of new ones would emerge unless the breeding places were eliminated.

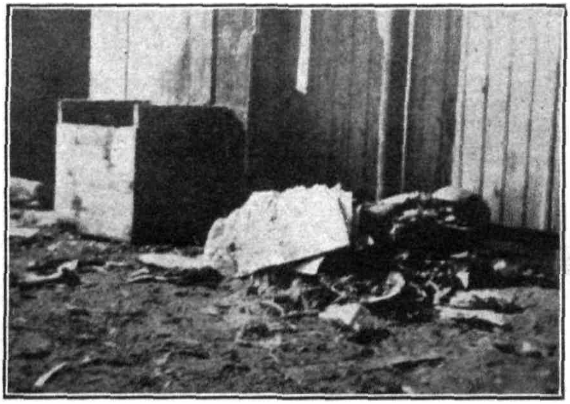


FIG. 190. — A breeding place for house flies.

Control of the house fly. Manure should be kept in closed boxes or closets and emptied every ten days. If it is spread over the ground so as to dry out, house flies will not breed in it.

Chloride of lime used on the manure pile is sometimes effective, as is a preparation of a distillate petroleum. Write to your Board of Health for further information.

In ridding a community of house flies your neighbor must do his share. If he does not help and there is no

way to make him, then you must screen your home and kill the adult flies as they slip in. A formaldehyde solution, one part to six of water, or milk, placed in small dishes will kill house flies readily. Remove other sources of drink.

Since house flies are known to transmit typhoid fever, tuberculosis, dysentery, summer diarrhœa in infants, Asiatic cholera, and other diseases, kill the fly and remove its breeding places.

Questions

1. What causes malaria?
2. How is malaria transmitted?
3. Explain the life history of the mosquito.
4. How may malaria be prevented?
5. Why is the house fly so harmful to human beings?
6. Discuss the life history of the house fly.
7. How may the house fly be eliminated?

Home Studies

1. How is yellow fever transmitted? Bubonic plague?

2. How has the death rate been lowered in the vicinity of the Panama Canal?

3. Locate breeding places for mosquitoes and flies. Try to get rid of them.

REVIEW QUESTIONS ON CHAPTERS XXXVII TO XLI INCLUSIVE

1. What care should be given to chickens and pigeons that they may live hygienically?

2. How may cotton be improved?

3. What may be done to increase the sugar content of sugar beets?

4. Name your two responsibilities.

5. Of what danger are house flies and mosquitoes?

6. How may each be controlled?

7. What causes the most sickness?

8. How are the public drinking cup, the roller towel, and other common community factors harmful?

A SECOND REVIEW OF CHAPTERS XXIII TO XLI INCLUSIVE

1. What is the relation of plants to animals?

2. What effect has burning gas on the atmosphere in a room?

3. Why are the pistil and the stamens so necessary in plant life?

4. How does nature make new life?

5. How are plants improved artificially? Naturally, and by nature?

6. How may soil be kept fertile?

7. Why do weeds grow so successfully?

8. Most insects are harmful to us. Have they any right to live? What right to life have dogs, horses, birds, and other animals?

9. What seems to be the aim of insect life?

10. Insects usually resemble in color and sometimes in shape the material on which they rest. Why is this?

11. If insects and other low animals multiply by the thousands, why do they not overrun the earth?

12. Explain the cause and spread of "leaf curl."

13. How may one become at least partly immune to diseases?

14. What might happen if a few men gain control of the forests, the mines, the banks, etc.?

15. Of what use are the United States Weather Bureau system, the experimental stations, and other institutions of a like nature? Are they of service to the people, or are they selfish in attitude?

16. How are the forces of nature being used in your community?

A BIRD'S-EYE VIEW OF THE BOOK IN QUESTIONS

1. Examine the community in which you live to answer the following questions. If you live in a town or city, —

a. Do the homes need beautifying both inside and outside? Are they conveniently arranged? See the score card for a city home.

b. Are the roads well kept?

c. Are the electric light company, the water company, the transportation company, giving good service?

d. Is the community's food supply inspected so that poor meat, milk, uncleanly vegetables, etc., may not be received by the people?

e. Are there many liquor houses in your town or city?

f. Is there much sickness?

g. Do unsightly vacant lots, manure piles, garbage heaps, abound?

h. How are you and the other people of your community being fed, clothed, housed? What work is being done by the men and women?

i. If the proper answers cannot be given to these questions, why do the conditions prevail? How might they be improved? Talk to your friends about this matter. Following are score cards for a community and a city home. Before moving score the town or city in which you live and the district in which you may be interested. Score your home.

If you live on or near a farm —

a. Answer Questions *a*, *b*, *c*, *d*, and *h* above.

b. Do a few people own most of the land near, or is it cut up into small farms? Which is the better?

2. What does the dandelion gain by having its flower lifted high? Why does the weed form so many seeds? The mushroom? Why does the female mosquito lay hundreds of eggs and the hen so few? Why do insects resemble in color the material on which they are found? Why are frogs so hard to see on the bottom of a pond? What is meant by the survival of the fittest?

3. What are you doing to help make your community more attractive?

4. What city would you rather live in, the city of B–Y or C–O? Which farm would you rather buy, A or B? See the score cards.

COMMUNITY SCORE CARD

"Urban Community"	Ideal 100	Cities of B—Y	C—O	Farm Homes	Ideal 100	A	B
Beautiful homes .	9	6	4	Control of water supply . . .	7	6	0
Attractive schoolhouses . . .	8	5	4	Fertile land . .	7	6	5
Substantial churches . .	5	4	3	Climate . . .	6	5	4
Vacant lots improved . . .	4	1	0	Transportation facilities . .	6	6	3
Wide paved streets . . .	4	3	2	Nearness to market . . .	6	6	3
Stone sidewalks .	2	1	1	Good schools .	6	5	3
Ornamental trees	3	1	2	Good roads . .	4	3	2

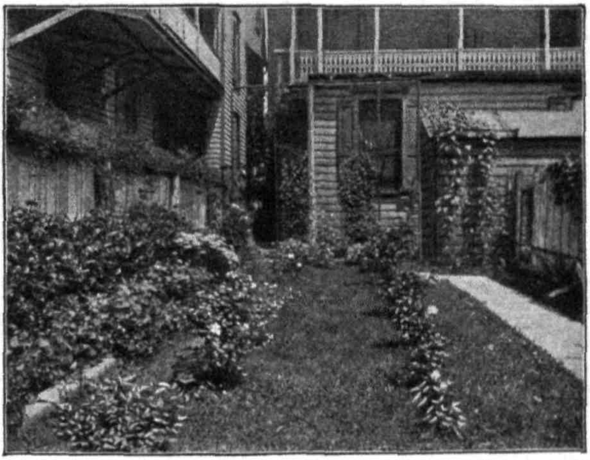
"Urban Community"	Ideal 100	Cities of B—Y	C—O
Electric and gas lights	4	2	3
Source of water supply	5	3	5
Transportation facilities	4	4	3
Inspection of food supply	7	2	0
Liquor—prohibition	7	2	0
Public health	6	5	4
Health inspector	6	2	1
Sewage system	6	5	4
Climate	5	4½	3
Progressive public spirit	7	6	2
Labor conditions	4	3	2
Desirable city officials	4	4	3
	100	63½	46

Farm Homes	Ideal 100	A	B
Convenient and beautiful homes	4	4	3
a. Large rooms			
b. Bathroom			
c. Electric lights			
d. Telephone			
e. Running water	2	2	0
Hygienic measures	2	2	0
High-bred stock	6	6	3
First-class machinery	5	5	4
Means for preventing waste	5	4	3
White labor	3	3	3
Crop rotation practiced	4	3	0
Land for experimental purposes	6	5	0
Methods for improving crops	5	4	3
Continuous fertilization	5	4	2
Sociable neighbors	5	4	3
Farmers' Coöperative Union	6	6	0
	100	89	44

CITY HOME SCORE CARD

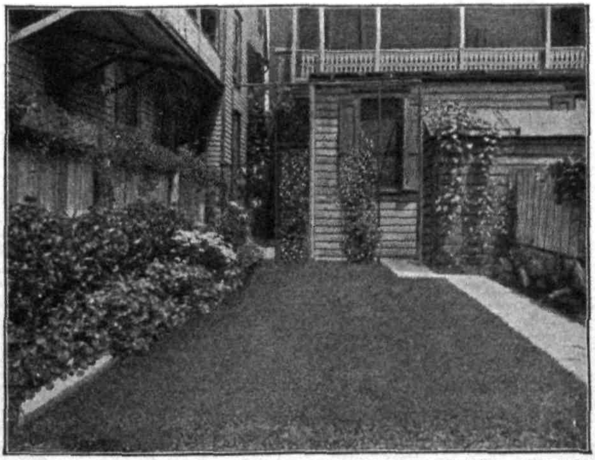
	Points
[1] Good drainage	4
[1] House facing south or west	3
[1] Windows arranged to give best view	3
[1] Open lawn	3
[1] Curved paths with border	3
[1] Shrubbery and flowers massed in corners (Fig. 192)	2
[1] Vines joining house to ground (Fig. 192)	3
[1] Trees well placed	2
Ornamental plants	2
Window boxes	2
[1] A general color scheme	2
[1] Flowers, etc., used to hide garbage cans and outbuildings	3
[1] An attractive back yard (page 341)	3
An attractive house	3
Rooms large, well lighted and ventilated	4
Sleeping porches	4
Closets, lighted and ventilated	3
[1] Bath and toilet	4
Small cabinet kitchen	2
Plate rail, dining room	1
Beamed ceilings	1
Dining room paneled	1
Cupboards and bookcases built in walls	2
Some color scheme inside	2
[1] Hardwood floors with rugs	4
Furniture and pictures simple and not crowded	3
[1] Telephone	3
[1] Electric light and gas	4
Furnace and fireplaces	3
Gas range and electric iron	3
[1] Mechanical washer (if washing is done)	4
Vacuum cleaner	3
Stationary laundry tubs	3
Clothes chute	3
Stationary ironing board	1
[1] Sewerage system	4
Total	100

[1] The more essential factors to be considered.



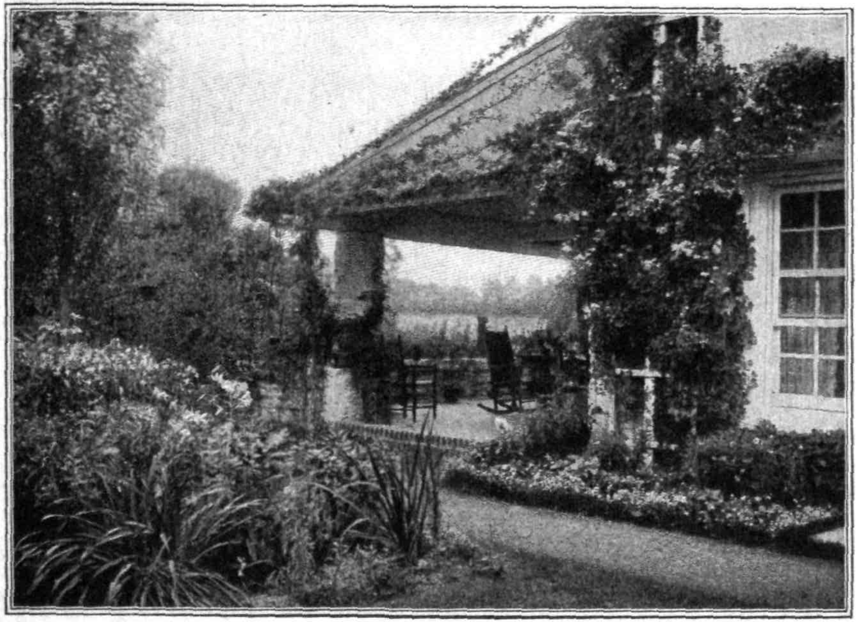
(*Courtesy Ladies' Home Journal.*)

FIG. 191. — A lawn before improving.



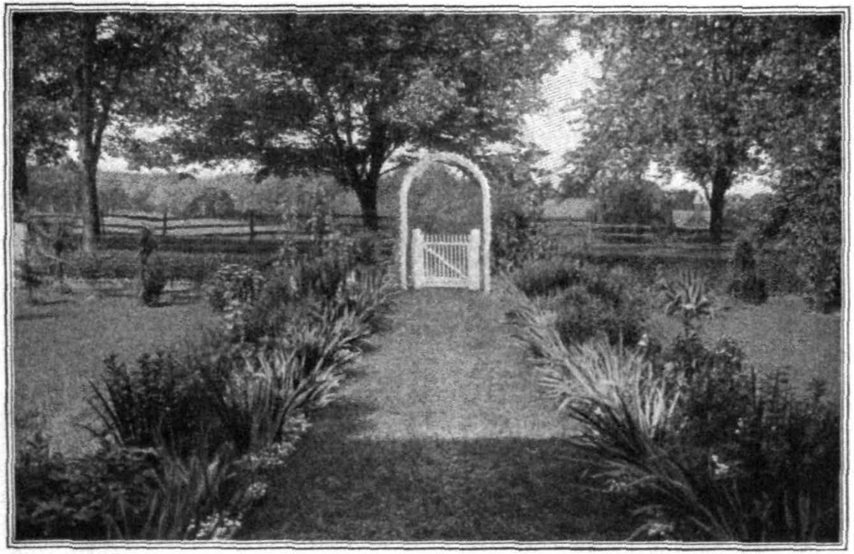
(*Courtesy Ladies' Home Journal.*)

FIG. 192. — The lawn after improving. Notice the open space.



(Courtesy Ladies' Home Journal.)

FIG. 193. — An attractive home.



(Courtesy Ladies' home Journal.)

FIG. 194. — Suggestions for a front walk.

5. Why cannot animals live without plants?
6. What is meant by the balance of life?
7. What is meant by a timber corporation? A steel corporation?
8. Which is the better way to keep well, to eat, sleep, and live carelessly and go to the doctor for a cure, or to live hygienically?

To the Teacher. In the introduction a beginning was made with this thought, to teach gardening, to teach agriculture, not for their own sake, so much as for the sake of those things towards which they point. The road has been long, yet the author hopes (1) that the traveling has been both pleasant and profitable for teacher and pupils alike, (2) that the arrival means the building of ideals potential in better homes, in better communities, and in citizenship directed by service rather than selfishness. For, after all, the question is not, How fertile is the land, How finely equipped is the school, How rich are the church finishings, but rather, How potential is the farmer, the teacher, the preacher? What are the qualities of the man?

APPENDIX

How to Make a Cold Frame

Build a frame as shown in Fig. 47 out of twelve-inch boards. Cover with cheesecloth. The cloth may be tacked to a pole and rolled back when necessary. In the winter,

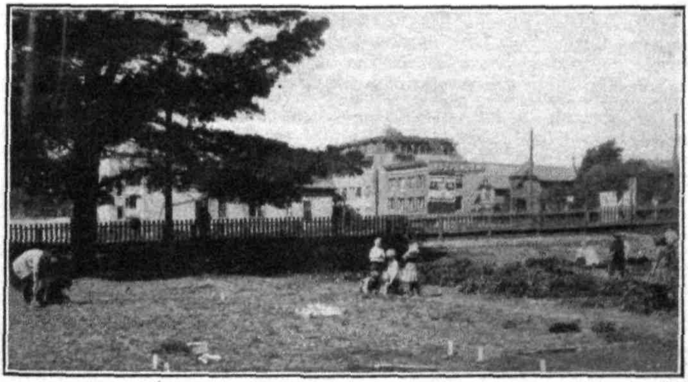


Fig. 195. — Laying out a school garden. (Drive the corner stakes first.)

a glass frame may take the place of the cloth. Arrange the glass frame so that it may be raised and opened when necessary on one side a few inches at least.

Flower and vegetable seeds germinate well under cover, and they may be given an early start. Cold frame lettuce is far more tender than that grown in the open.

How to Lay Out a School Garden

Bring tools to school. Prepare stakes, fourteen inches long, $1\frac{1}{4} \times 1\frac{1}{4}$ inches, sharpened at one end, three to each pupil. The stakes should be painted white. With a tape measure, yardstick, stones or mallets, two or three balls of string, and a plan, you are ready to lay out the gardens. Half a dozen boys with work planned for each can lay out a

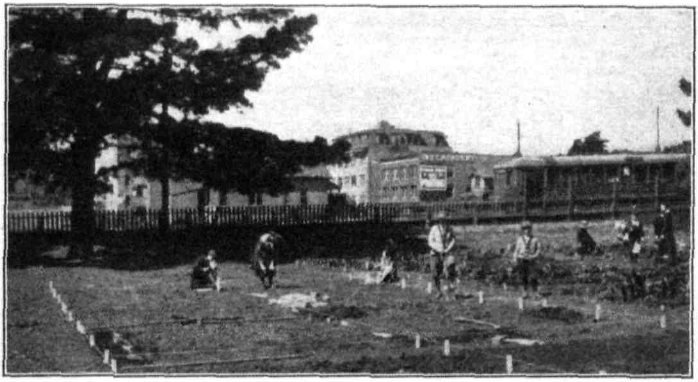


Fig. 196.—Drive stakes on the edges and connect with string.

plot a half acre in size in one hour by using the following method: Two boys should measure and mark off the four corners (Fig. 195). One boy should follow, carrying stakes, another accompanying him to drive the same. One boy should carry string. Stretch the string around the four corner stakes. Let boys with yardsticks measure off distances according to the plan and mark the places for stakes on two sides (Fig. 196). See that the stakes are always driven on the same side of the string. Let boys with mallets

and stakes follow, driving the stakes carefully in their proper places. With the stakes driven on opposite sides, others should stretch string across, connecting the corresponding stakes. The string need not be broken at each stake. It may be merely wound and carried on to the next stake. With stakes driven at their respective distances at the two

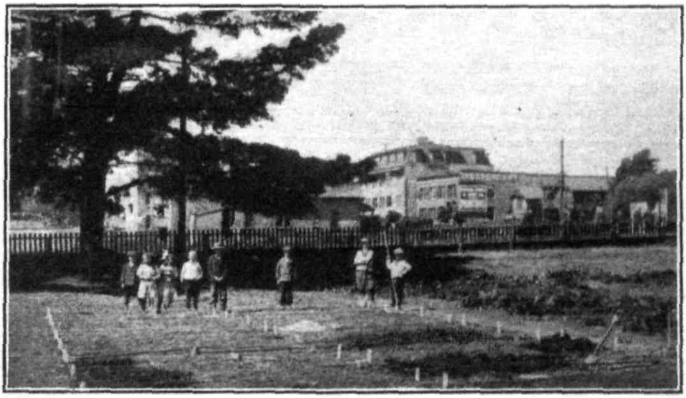


FIG. 197. — Drive stakes where the strings intersect.

remaining sides, treat as above with the string. The garden now has the appearance of a great cobweb with the string crossing in such a way as to outline each garden. The whole class may now be used to drive stakes at each intersection of the string (Fig. 197). Use great care to drive the stakes perpendicularly and on the correct side of the string. With the stakes in place, unwind the string. Do not let the string remain. It stretches and is easily broken.

BIRD STUDY OUTLINE

Date..Size..

Description: Forehead........................Crown........................

Nape....................Back....................Rump....................

Tail..Bill..

Chin..Throat..

Breast..

Movements..

Song..Flight..

Habitat..

Localities Frequented..

....

Food..

Points Peculiar to this Bird..

....

....

Remarks..

Notes

(To be used with bird study outline)

Size. Compare with English sparrow, robin, and crow.

Description. Follow points as indicated on the cut (page 215), giving colors of crown, nape, back, rump, etc., indicating differences between male and female.

Movements. Hop, run, bob head or tail, or both, sit quietly or flit about continuously, nervous or deliberate.

Song. Harsh, sweet, notes long drawn out or in series, variety of notes, one or more calls, call in flight or at rest, or both. What does the bird seem to say in our words? Use dots, dashes, and curved lines to indicate calls.

Flight. Direct, zigzagging, diving, sailing, undulating, or combinations of these.

Habitat. Trees (high up or low down), shrubs, ground, buildings, water.

Localities frequented. Meadows, forests, orchards, homes, foothills.

Food. Insects, grain, fruits, seeds, vegetables. (Determine economic value.)

Points peculiar to this bird. Bill short and stubby, seed eater; or long and slender, broad at base, insect eater; or long and very slender, nectar gatherer; or stout and hooked, flesh tearers; or long and chisel-shaped, woodpecker. Feet, wide toes, webbed toes; arrangement, toes for climbing, scratching, perching, or grasping.

Tail. Feathers stiff and pointed, forked or rounded.

Remarks. Points not covered by the outline: Striking characteristics in color, habits, food, etc. Birds seen in flocks, pairs, or singly; nest building; raising of young; food of nestlings, etc.

TREES: EVERGREEN

TREES	WHEN TO PLANT	TIME TO COME UP	REMARKS
Acacia	Feb.–May	5–20 da.	Soak 24 hours in warm water. Easily grown
California Laurel	Feb.–May or fall	10–14 da.	Start in damp sand
Coast Redwood	Feb.–May or fall	14–21 da.	Place young seedlings in cans, pots, or fruit baskets
Cypresses	In the fall	15–30 da.	Place young seedlings in cans, pots, or fruit baskets. Easily grown
Eucalypti	Feb.–May	8–14 da.	Place young seedlings in cans, pots, or fruit baskets. Easily grown
Lemon	Feb.–May	30–40 da.	
Loquat	Feb.–May	25–35 da.	Stratify
Orange	Feb.–May	40–50 da.	
Olive	Feb.–May	50–60 da.	File openings in seed before planting
Pepper Tree	Any time	10–20 da.	Easily grown
Pines	Feb.–May	10–20 da.	File openings in seed. Easily grown

TREES: DECIDUOUS

TREES	WHEN TO PLANT	TIME TO COME UP	REMARKS
Apple	Feb.–May	30–50 da.	Easily grown
Apricot	Feb.–May	30–50 da.	Stratify. Easily grown
Box Elder	Feb.–May	30–50 da.	
Cal. Black Walnut	Any time	30–60 da.	Stratify. Easily grown
Linden	Feb.–May	30–60 da.	Stratify
Maple	Spring and fall	30–50 da.	
Oaks	Spring and fall	30–50 da.	Easily grown

I. Plant Calendar

Plant	When to Sow	Days to come up	Days to Maturity	Amount of Water	Height of Plant	Color of Flower	Diseases and Symptoms	Remedy	Remarks
Artichoke	Jan.–Feb.		1 yr.	Large	6 ft.				May be *propagated* by roots
Asparagus	Feb.–Mar.		2–3 yr.	Large	3 ft.		Rust. In summer, brownish spots on stems. In winter, long black streaks on stems	Sulphur	
Beans (string)	Feb.–Apr.	6–10	2–3 mo.	Large			*Anthracnose.* Circular spots on pods, stems, and leaves Blight. Dead spots on leaves	Spray with B. M. when plants come up	Also spray when first pair of leaves expand and when pods have developed
Beans (pole)	Feb.–May	6–12	70–90	Large	6 ft.		Rust. Rusty spots on leaves. Root and stem rot	Plant resistant *varieties.* Lime the soil	Arrange poles for the plant *to climb* upon
Beets . .	Any time	7–10	3–5 mo.	Large	14″		Leaf spot. Circular spots on leaves Root rot. Base of leaves black. Root rotted	Spray every 10 days with B.M. Crop rotation	Beets are cold weather plants. The seeds do best if planted early in the spring
Cabbage (early)	Sept.–Oct.	5–10	3–7 mo.	Large	18″		Black rot. Leaves yellow, then fall off	Put seeds *in* mercuric bichloride 1–1000	Needs much attention
Cabbage (late)	Feb.–Mar.	5–10	3–4 mo.	Large	18″		Clubroot. Plant stunted. Roots deformed	Crop rotation	
Cauliflower	Feb.–Mar.	5–10	3–4 mo.	Large	18″		Same as cabbage		

I. Plant Calendar (*continued*)

Plant	When to Sow	Days to come up	Days to Maturity	Amount of Water	Height of Plant	Color of Flower	Diseases and Symptoms	Remedy	Remarks
Carrot	Any time	10–18	4–6 mo.	Large	12″				Excellent for school gardens
Celery	Feb.–Apr.		6–8 mo.	Large			Early blight. Yellowish spotted leaves	Spray with B. M. often	Time may be gained by buying small plants
Chard	Any time	7–10	3–5 mo.	Large	14″				Excellent for school gardens
Corn	After frost		2–3 mo.	Small	6′		Smut. Kernels enlarge and covered with blackish spore-powder	Spray with B. M. Remove and burn infected parts	Keep the corn clean from suckers
Cucumber	After frost	6–10	2 mo.	Small			Downy mildew. Yellow leaves later drying up Wilt. Plants wilt rapidly	Spray with B. M. every 10 days B.M.	May be started early in fruit baskets and transplanted later
Eggplant	After frost	8–16	3 mo.	Small					
Kohl-rabi	Aug.–Apr.	5–10	4 mo.	Large					Excellent for school gardens
Lettuce	Any time	5–8	4–6 weeks	Large			Downy mildew. Leaves turn yellow	Use sub-irrigation. Keep on dry side	Excellent for school gardens
Melons	After frosts	6–10	3–4 mo.	Small			See diseases of cucumber		
Onion	Seed Feb.–May Aug.–Nov.	8–12	4–6 mo.	Large			Mildew. Gray mildew on leaves	Spray with B. M. every 10 days	Start in a cold frame

Onion .	Sets. Oct.–Apr.	4–6	1½ to 3 mo.	Large			Smut. Black postules on bulbs and leaves	Crop rotation Lime and sulphur	
Parsley .	Aug.–May	12–14	60	Large					
Parsnip .	Aug.–Nov. Feb.–Apr.	10–20	2–5 mo.	Large					
Peas . .	Any time	6–12	2–5 mo.	Large			Downy mildew. Downy patches on pods and leaves	Spray with B. M. every 10 days	Burn diseased parts
Potato . (Irish) .	Feb.–May Aug.–Sept.	10–20	2–4 mo.	Small			Scab. Scabby tubers Dry rot. Wilting of tops	Soak in formalin solution 2 hr., 1 pt. to 30 gal. water. Rotation	Cultivate often
Pumpkin .	After frosts	6–12	5–6 mo.	Small			Downy mildew. Yellow leaves, later drying up	Spray with B. M. every 10 days	
Radish .	Any time	3–6	1–2 mo.	Large					
Spinach .	Any time	6–10	6–10 weeks	Large					
Squash .	After frosts	10–16	5–6 mo.	Small			Wilt. Plants wilt rapidly Downy mildew. Yellow leaves dry up	Use B. M. every 10 days	
Tomato .	Seeds Feb.–Apr.	6–12	3–5 mo.	Small			Leaf spot. Minute angular spots on leaves	Use B. M. every 10 days	Start seeds early and transplant seedlings after frosts are over
Turnips .	Aug.–Nov. Feb.–Apr.	4–8	2–3 mo.	Large			Clubroot. Roots deformed Soft rot. Soft slimy rot of root	Resistant varieties Crop rotation	

II. Flower Calendar

Plant	Bloom	Height	Color	Remarks
Sweet Alyssum	Jl. – O.	10	W.	For edging
Stocks	Ju. – O.	18	W.	Massing (boxes)
Petunia	Ju. – O.	14	W.	Massing (boxes)
Four o'Clocks	Jl. – A.	15	W.	Massing
Candytuft	Jl. – S.	15	W.	Profuse — easy cult.
Ageratum	Ju. – O.	32	W.	Profuse — Continuous
Daisies, Shasta	Jl. – O.	30	W.	Massing (boxes)
Godetia	Jl. – O.	10	W.	Massing
Sweet Sultan	Jl. – O.	18	W.	Very showy
Chrysanthemum . . .	Jl. – O.	22	W.	Very showy
Zinnia	Jl. – O.	18	W.	Very showy
Aster	Jl. – O.	18	W.	Very showy
Ageratum	Ju. – O.	32	B.	Profuse
Bachelor's-B.	Jl. – O.	12–18	B.	Showy
Petunia	Ju. – O.	14	D. B.	Massing
Phlox	Jl. – O.	15	B.	Bedding — borders
Portulaca	A. – O.	8	D. B.	Edging — massing
Salvia	A. – O.	30	L. B.	Bedding
Larkspur	Jl. – S.	30	B.	Bedding
Verbena	Jl. – O.	15	B.	Massing — edging
Zinnia	Jl. – O.	22	B.	Bedding
Aster	Jl. – O.	18	B.	Showy
Lobelia	Jl. – O.	8	L. B.	Edging
Scarlet Flax	Jl. – O.	24	R.	Very showy — mass
Salvia	Jl. – O.	30	R.	Very showy — mass
Clarkia	Jl. – O.	28	L. R.	Very showy
Gaillardia	A. – O.	19	R. d. c.	Very showy
Godetia	Jl. – O.	10	R.	Very showy
Balsam	Jl. – O.	30	R.	Massing
Stocks	Jl. – O.	22	R.	Massing
Poppies	Jl. – O.	30	R.	Bedding and borders
Phlox D.	Jl. – O.	14	R.	Bedding and borders
Portulaca	Jl. – O.	8	D. R.	Bedding
Verbena	Jl. – O.	15	R.	Massing
Zinnia D	Jl. – O.	21	R.	Edging — buildings
Sweetpea	Jl. – O.	60	R.	
Geranium	Jl. – O.	30	R.	Borders
Calendula	Jl. – O.	20	Y.	Easy of culture
Calliopsis	Jl. – O.	22	Y.	Bedding
Sweet Sultan	Jl. – A.	18	Y.	Very showy

Plant	Bloom	Height	Color	Remarks
Chrysanthemum . . .	Jl. – O.	32	Y.	Very showy
Cal. Poppies	Jl. – O.	24	Y.	Very showy
Gaillardia	Jl. – O.	14	Y.	Very showy
Sunflowers	Jl. – S.	72	Y.	Backgrounds
Fr. Marigold	Jl. – O.	30	Y.	Showy beds
Nasturtiums	Jl. – O.	12	Y.	Showy beds
Zinnia	Jl. – O.	24	Y.	Showy beds

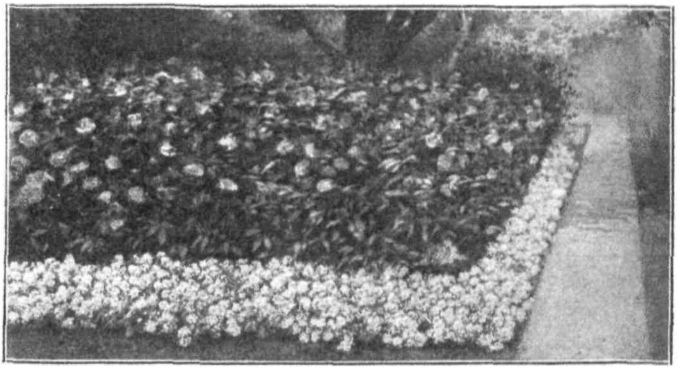


Fig. 198. — An attractive flower bed.

Flower Gardens

Garden No. 1

Mass bulbs in a bed, sow broadcast among the bulbs dwarf sweet alyssum; bloom in January and February.

Garden No. 2

Sow Gaillardia at the back. Mass dwarf sweet alyssum in front. Bloom in June and July.

Garden No. 3

Bachelor's-buttons, massed in the center with a border of sweet alyssum. Bloom in fall.

Garden No. 4

Mass Calendula in the center with a border of dwarf nasturtiums. Bloom in fall.

Garden No. 5

Masses of verbenas, petunias, daisies, or asters. Bloom in summer and fall.

Garden No. 6

Grow asters behind and pansies or low-growing daisies in front. Bloom in fall.

Garden No. 7

A mass of iris with a border of feverfew. Bloom in March and April.

Garden No. 8

Mass in scarlet flax with a border of lobelia.

Consult the following diagram and select flowers from the flower calendar according to color, height, and blooming period. Colors which are opposite or nearly opposite on the diagram are safe combinations. Thus red and yellow, red and blue, red and green, are good combinations.

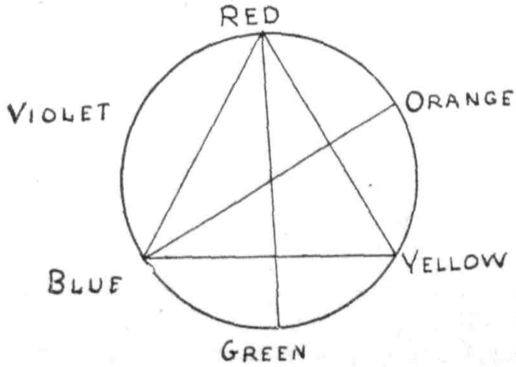


FIG. 199.

A plant calendar must, in the main, be local in nature. However, the rule is, "Allow six days difference for every hundred miles of latitude; north, later; south, earlier." Use the principles outlined in the text.

Many plants thrive when given water freely. However, garden practice is beginning to show that more cultivation and less irrigation give better results.

Seeds of the following trees should be planted as soon as they are ripe: Acacia, maple, chestnut, araucaria, madrona, birch, camellia, ash, holly, magnolia, oak, linden, elm.

Do not grow shades of the same color together unless the difference is quite evident.

Avoid growing red flowers against a red brick wall.

White and green may be used to bring a color harmony among flowers of the same shade. For example, white alyssum between two shades of blue is allowable.

GARDEN CALENDAR[1]

January

VEGETABLE GARDEN

Spread a good thick dressing of stable manure over the garden plat and work deeply into the soil. Sow beet, early cabbage, carrot, kohl-rabi, lettuce, onion, parsley, parsnip, peas, radish, spinach, and turnip. Plant potatoes, asparagus, and rhubarb roots.

FLOWER GARDEN

Fertilize the plat in which flowers are to be grown, following the directions as given above. Sow sweet alyssum, Calendula, Calliopsis, candytuft, Centaurea, Clarkia, cosmos,

[1] For California conditions.

poppy, Gaillardia, larkspur, mignonette, and sweetpeas. Many of these may be planted in the open or in flats.

February

Plant deciduous fruit trees.

VEGETABLE GARDEN

In addition to the vegetables suggested for January, sow eggplant, peppers, and tomatoes in hotbeds or cold frames.

FLOWER GARDEN

Set out roses and all kinds of ornamental trees and shrubs. To the list of flowers suggested for January, add balsam, begonia, lobelia, verbena, petunia, and salvia. Sow the seeds in boxes in order that the seedlings may be transplanted.

March

This is a good month for the planting of deciduous and citrus fruit trees.

VEGETABLE GARDEN

Sow artichoke, beans, sweet corn, pop corn, cucumber, eggplant, squash, tomatoes, and any of the vegetables suggested for January or February.

FLOWER GARDEN

Continue to plant roses and ornamental trees and shrubs. The seeds suggested for February may also be planted during this month. This is the best time in which to sow most kinds of tree seeds. Plant gladiolus, begonia, and dahlia bulbs.

April

VEGETABLE GARDEN

In addition to the seeds suggested for January and February, sow late cabbage and cauliflower, also muskmelon, watermelon, pumpkin, rhubarb.

FLOWER GARDEN

Sow aster, morning-glory, cosmos, oriental poppy, portulaca, polyanthus, Shasta daisy, verbena, wallflower, and zinnia. Plant begonia and dahlia bulbs; also chrysanthemum and aster plants.

May and June

VEGETABLE GARDEN

Plant any of the cold and warm weather vegetables.

FLOWER GARDEN

Continue planting as suggested in the month of April.

July

VEGETABLE GARDEN

Sow beans, beets, Brussels sprouts, cucumber, kohl-rabi, lettuce, onion, parsley, peas, pumpkin, radish, spinach, and summer squash. Plant out Brussels sprouts, cabbage, and cauliflower plants.

FLOWER GARDEN

Sow cosmos, nasturtium, and portulaca seed.

August

VEGETABLE GARDEN

During this month plant seeds of the ordinary cold and warm weather vegetables.

FLOWER GARDEN

Sow pansy, stocks, and sweetpeas which will flower during Christmas week.

September

VEGETABLE GARDEN

Sow beets, early cabbage, and cauliflower, carrot, lettuce, onion, parsley, parsnip, peas, potatoes, radish, spinach, etc.

FLOWER GARDEN

Sow campanula, cineraria, pansy, pentstemon, oriental poppy, Shasta daisy, stocks, sweetpeas.

October

VEGETABLE GARDEN

Follow directions as given for the month of September.

FLOWER GARDEN

Sow hardy annuals in the open ground. Also wild flowers. Plant hyacinth, tulips, narcissus, and jonquils.

November

VEGETABLE GARDEN

Sow the seeds of cold weather vegetables.

FLOWER GARDEN

Sow wild flowers after the first rains. Continue planting bulbs.

December

VEGETABLE GARDEN

Spread a good thick dressing of stable manure over the surface of the garden plat.

FLOWER GARDEN

Treat as directed above. Continue to sow hardy annuals as the weather permits.

SOME INSECTICIDE AND FUNGICIDE REMEDIES

For Plants

Insects that eat foliage, fruits, flowers, etc., whether they are worms, caterpillars, or slugs, etc., are best destroyed by some poisonous insecticide, such as Arsenate of Lead, Paris Green, or Hellebore. If for any reason it is not deemed safe to use a poison, the next best non-poisonous insecticides are Persian Powder, Kerosene Emulsion, Tobacco Extract, or Tobacco Dust.

Insects that suck the juices of plants, such as lice, green and black fly, red spider, scale, mealy bug, etc., can only be destroyed by skin-irritating insecticides, such as Kerosene Emulsion, Extract of Tobacco, Tobacco Dust, or Whale Oil Soap.

Plants and fruits affected by fungous disease, such as mildew, dry rot, rust, etc., should be promptly treated with Bordeaux Mixture.

For tree borers. Insects on trunks, eggs on bark. To prevent crawling up the trunk, use Whale Oil Soap or Tree Tanglefoot.

Never apply insecticides or fungicides when fruits are in bloom; it kills the bees and affects pollination.

Application of Insecticides and Fungicides is best done for fluid solution with a spray pump, knapsack sprayer, syringe, or vaporizing bellows. In powder form they are best applied with a powder gun, bellows, or duster.

Arsenate of Lead. A poison rapidly taking the place of Paris Green. Its great advantages are that it adheres well to the foliage, and spraying does not have to be repeated, as it does not readily wash off by rain. It also remains well suspended in solution so that an even distribution can be

obtained. It is white in color and shows just where it has been applied. It does not injure tender foliage.

A. L. For young and tender vegetation 1 pound to a 40-gallon barrel of water will usually be strong enough; for hard-wooded plants the strength can be increased up to 2 or 3 pounds. Apply as a spray.

Bordeaux Mixture. A fungicide, curing and preventing black rot, mildew, blight rust, scab, and all fungous diseases of fruits and plants.

B. M. Dissolve 1 gallon to 50 gallons of water, and apply in a spray.

B. P. A combined fungicide and insecticide is best made by adding 1 pound of Paris Green to 150 gallons Bordeaux spray prepared as above.

Kerosene Emulsion. Ready for use by simply adding water. For cabbage "worms," scale on trees, caterpillars, melon louse, rose bugs, green fly, and lice of all kinds, all sucking insects, either on plants or animals.

K. E. Mix 1 part Emulsion to 25 to 50 gallons of water; according to strength required. Spray on.

Whale Oil Soap. Makes an excellent wash for trees and plants where insects and eggs affect the bark, and for smearing on the trunks of trees to prevent "worms" from crawling up.

W. O. For insects on plants, dissolve $\frac{1}{4}$ pound to a gallon of water. Apply with syringe or spraying pump.

W. O. For bark insects, etc., dilute with water to consistency of thick paint, and apply with brush.

THE LONGEVITY OF GARDEN SEEDS

	AVERAGE	EXTREME		AVERAGE	EXTREME
	Years	Years		Years	Years
Bean	3	8	Okra	5	10
Beét	6	10	Onion	2	7
Cabbage	5	10	Parsnip	2	4
Carrot	4 to 5	10	Parsley	3	9
Cauliflower	5	10	Peas	3	8
Celery	8	10	Pepper	4	7
Corn	2	4	Pumpkin	4 to 5	9
Corn (salad)	5	10	Radish	5	10
Cress (garden)	5	9	Rhubarb	3	8
Cress (water)	5	9	Sage	3	7
Cucumber	10	10	Salsify	2	8
Eggplant	6	10	Savory	3	6
Kohl-rabi	5	10	Sea kale	1	7
Leek	3	9	Spinach	5	7
Lettuce	5	9	Squash	6	10
Melon, musk	5	10	Thyme	3	7
Melon, water	6	10	Tomato	4	9
Nasturtium	5	8	Turnip	5	10

LIST OF APPARATUS FOR CLASSROOM

3 flat bottles.
6 4-oz. bottles.
6 student lamp chimneys or glass tubes, 6 inches × $\frac{3}{4}$.
6 tumblers.
2 table plates.
2 discarded camera plates.
1 glass funnel.
6 test tubes.
1 test tube oxygen generator.
2 fruit jars.
1 alcohol lamp or Bunsen burner.
1 magnifying glass.
Glass tubing, 3 or 4 feet.
1 bottle mucilage.
1 bottle vaseline.
8 chalk boxes.

6 flats.
1 small file.
6 4-in. flower pots.
6 4-in. paper pots.
6 tin cans.
1 small sheet of blue litmus paper.
Rubber tubing — 3 feet.
A few corks — different sizes.
2 teaspoons.
1 broken clock spring.
1 tripod.
2 thermometers.
A little wire fly screen.
A few blotters.
A small amount of cotton.
Mosquito netting.
2 balls of string.
A few rubber bands.
A small amount of starch, sugar, eosin, salt, iodine, lime, marble, sawdust, blue vitriol, formaldehyde, acid, cardboard, potassium chlorate.
A few walnuts.
A small candle.
Fertilizers.
Sand, clay, humus.
Celluloid, or rubber balls.
Mercury.

Total cost not over $3.50.

FARMERS' BULLETINS

Bulletins in this list will be sent free, so long as the supply lasts, to any resident of the United States, on application to his **Senator, Representative, or Delegate in Congress**, or to the Secretary of Agriculture, Washington, D.C. Because of the limited supply, applicants are urged to select only a few numbers, choosing those which are of special interest to them.

22. The Feeding of Farm Animals.
28. Weeds; and How to Kill Them.
35. Potato Culture.
44. Commercial Fertilizers.
49. Sheep Feeding.
51. Standard Varieties of Chickens.
52. The Sugar Beet.
54. Some Common Birds.
55. The Dairy Herd.
61. Asparagus Culture.
62. Marketing Farm Produce.

64. Ducks and Geese.
77. The Liming of Soils.
86. Thirty Poisonous Plants.
91. Potato Diseases and Treatment.
93. Sugar as Food.
96. Raising Sheep for Mutton.
99. Insect Enemies of Shade Trees.
106. Breeds of Dairy Cattle.
113. The Apple and How to Grow It.
121. Beans, Peas, and Other Legumes as Food.
126. Practical Suggestions for Farm Buildings.
127. Important Insecticides.
131. Household Tests for Detection of Oleomargarine and Renovated Butter.
134. Tree Planting on Rural School Grounds.
138. Irrigation in Field and Garden.
145. Carbon Bisulphid as an Insecticide.
150. Clearing New Land.
152. Scabies of Cattle.
154. Home Fruit Gardens: Preparation and Care.
155. How Insects Affect Health in Rural Districts.
157. The Propagation of Plants.
170. Principles of Horse Feeding.
172. Scale Insects and Mites on Citrus Trees.
173. Primer of Forestry. Part I: The Forest.
179. Horseshoeing.
181. Pruning.
182. Poultry as Food.
183. Meat on the Farm: Butchering, Curing, etc.
185. Beautifying the Home Grounds.
188. Weeds used in Medicine.
192. Barnyard Manure.
194. Alfalfa Seed.

195. Annual Flowering Plants.
196. The Usefulness of the American Toad.
198. Strawberries.
200. Turkeys.
205. Pig Management.
206. Milk Fever and its Treatment.
213. Raspberries.
218. The School Garden.
220. Tomatoes.
228. Forest Planting and Farm Management.
229. The Production of Good Seed Corn.
236. Incubation and Incubators.
241. Butter Making on the Farm.
242. An Example of Model Farming.
243. Fungicides and their Use in Preventing Diseases of Fruits.
245. Renovation of Worn-out Soils.
248. The Lawn.
250. The Prevention of Stinking Smut of Wheat and Loose Smut of Oats.
254. Cucumbers.
255. The Home Vegetable Garden.
256. Preparation of Vegetables for the Table.
257. Soil Fertility.
263. Information for Beginners in Irrigation.
264. The Brown-tail Moth and How to Control It.
266. Management of Soils to Conserve Moisture.
270. Modern Conveniences for the Farm Home.
272. A Successful Hog and Seed-corn Farm.
275. The Gypsy Moth and How to Control It.
278. Leguminous Crops for Green Manuring.
279. A Method of Eradicating Johnson Grass.
282. Celery.

283. Spraying for Apple Diseases and the Codling Moth in the Ozarks.
287. Poultry Management.
289. Beans.
293. Use of Fruit as Food.
295. Potatoes and Other Root Crops as Food.
298. Food Value of Corn and Corn Products.
324. Sweet Potatoes.
339. Alfalfa.
345. Some Common Disinfectants.
347. The Repair of Farm Equipments.
348. Bacteria in Milk.
351. The Tuberculin Test of Cattle for Tuberculosis.
354. Onion Culture.
355. A Successful Poultry and Dairy Farm.
356. Peanuts.
357. Methods of Poultry Management at the Maine Agricultural Experiment Station.
358. A Primer of Forestry. Part II: Practical Forestry.
359. Canning Vegetables in the Home.
363. The Use of Milk as Food.
369. How to Destroy Rats.
371. Drainage of Irrigated Lands.
373. Irrigation of Alfalfa.
375. Care of Food in the Home.
377. Harmfulness of Headache Mixtures.
379. Hog Cholera.
380. The Loco-weed Disease.
383. How to Destroy English Sparrows.
386. Potato Culture on Irrigated Farms of the West.
389. Bread and Bread Making.
392. Irrigation of Sugar Beets.
397. Bees.

398. Farm Practice in the Use of Commercial Fertilizers in the South Atlantic States.
399. Irrigation of Grain.
401. Protection of Orchards in Northwest from Spring Frosts by Fires and Smudges.
404. Irrigation of Orchards.
406. Soil Conservation.
407. The Potato as a Truck Crop.
408. School Exercises in Plant Production.

CALIFORNIA BULLETINS[1,2]

149. California Sugar Industry.
151. Arsenical Insecticides.
165. Asparagus and Asparagus Rust in California.
170. Studies in Grasshopper Control.
176. Sugar Beets in the San Joaquin Valley.
178. Mosquito Control.
181. The Selection of Seed Wheat.
183. The California Tussock Moth.
185. Report of Progress in Cereal Investigation.
190. The Brown Rot of the Lemon.
191. California Peach Blight.
192. Insects Injurious to the Vine in California.
197. Grape Culture in California: Improved Methods of Wine-making, Yeast from California Grapes.
199. Bovine Tuberculosis.
207. The Control of the Argentine Ant.

[1] Write to the Agricultural Department University of California, Berkeley, California.

[2] Each state agricultural college issues helpful bulletins. If you do not live in California write to your agricultural college for a list of its publications.

208. The Late Blight of Celery.
211. How to Increase the Yield of Wheat in California.
212. California White Wheats.
214. Citrus Fruit Insects.
215. *The House Fly in its Relation to Public Health.*
217. Honey Plants of California.
218. California Plant Diseases.
219. Report of Live Stock Conditions in Imperial County, California.

CIRCULARS

7. Remedies for Insects.
11. Fumigation Practice.
12. Silk Culture.
15. Recent Problems in Agriculture.
    What a University Farm is For.
19. Disinfection of Stables.
29 Preliminary Announcement concerning Instruction in Practical Agriculture upon the University Farm, Davis, California.
30. White Fly in California.
32. White Fly Eradication.
39. Instruction in Practical Agriculture at the University Farm.
46. Suggestions for Garden Work in California Schools.
48. Butter Scoring Contest, 1909.
49. Insecticides.
52. Information for Students concerning the College of Agriculture.
55. Farmers' Institutes and University Extension in Agriculture.
58. Experiments with Plants and Soils in Laboratory, Garden, and Field.

59. Tree Growing in the Public Schools.
61. University Farm School.
62. The School Garden in the Course of Study.
63. How to Make an Observation Hive.
66. Insecticides and Insect Control.
67. Development of Secondary School Agriculture in California.
68. The Prevention of Hog Cholera.
69. The Extermination of Morning-glory.
70. Observations on Status of Corn-growing in California.

A METHOD SUGGESTED FOR CONDUCTING THE WORK

CHAPTER I

The Soil

Unit of instruction. The soil.

General topic aim. To interest the children in soil; to teach the relation existing between soil and the children.

Specific lesson aim. To teach the composition of the soil; to teach some of the physical characteristics of clay, sand, and humus.

Method of approach. The first step in *any* lesson is to make the children feel the need of the new work. Soil in the minds of the children is nothing but " dirt " which is always in the way. Show the children through such questions as: Where does glass come from? Where does linen come from? that nearly everything which we need comes from the soil. From the soil radiate the factors which constitute our en-

vironment. See Fig. 2, *The Principles of Agriculture through the School and the Home Garden.*

Teacher's preparation.

(1) Supplement subject matter by reading and observation.

(2) Supply the school with apparatus as listed in the Appendix.

(3) Select pupils to arrange material as outlined in the text, for demonstration purposes.

(4) Material necessary for the lesson: medium-sized, wide-mouthed bottle; small amount of soil containing sand, humus, and clay; a canful of dry sand, of dry clay, of dry leaf mold; a handful of small shot and one of buck shot; two small vessels of equal size to hold the shot; two tumblers or cans to hold sand and clay; alcohol lamp or Bunsen burner; a small piece of tin (the top of a baking powder can will do very well); a little lime; two chalk boxes or cans; two thermometers (one may be made to suffice).

(5) Put drawings 2 and 3, *P. A.*, on the board; read the note at the end of Chapter I, *P. A.* The material needed is outlined in Lesson 2 of the *Manual.*

(6) Plant radish seeds in a chalk box.

(7) Place in the medium-sized bottle a small amount of garden soil. Add water until the bottle is nearly filled. Shake well and set aside (Fig. 1, *P. A.*).

(8) Secure samples of clay, sand, and humus. Keep a sample of each for demonstration. Place a canful of each in the sun a few minutes before the lesson.

NOTE. All exercises should be performed. Experiments may be set up by the children or by the teacher. Let this become a special privilege for deserving children. The experiments should be arranged far enough ahead to be ready for the lesson. That is,

if the teacher wishes to teach that seeds need air for germination, the experiment should be set up a week or more before the lesson. The teacher should observe this suggestion carefully. Note the suggestions at the end of each chapter in the text.

The Lesson

Sand has coarse texture, clay has fine. Examine these samples. (Teacher gives each pupil a sample of sand, clay, and humus.) Name each. Observe carefully. In which are the particles the larger? In which do they roll about the more easily? Would you rather plow sandy soil or clayey soil? Why? On the board is a picture of sand and clay particles much enlarged. (Have the children feel samples of different soils. The gritty soils are sandy. "Soapy" soils are clayey.)

The mason builds a chimney by piling brick on brick. Nature builds a chimney in the soil by piling soil particles on each other. We have a better name than chimneys for these hairlike soil tubes. It is capillary tubes. Capillary means like a hair. In which are the tubes the larger, the clay or the sand?

Soil is composed of clay, sand, and humus. (The bottle in Exercise 1 should have been standing at least 24 hours.) I placed garden soil in this bottle, added water, and shook it. What do you find at the bottom? What is just above the sand? What is this material lying on the clay and floating on top of the water? Of what is soil composed?

Clay soil has a large pore space. You have learned that the particles of the sand are larger than those of the clay. Let us look again at the drawing I have made on the board (Fig. 3, *P. A.*). It is to represent sand and clay particles very much enlarged. Look at this bottle full of BB shot and this one full of fine shot. What is between the shot?

In which bottle are the air or pore spaces the larger? In which is there the greater amount of air space? You disagree; how may we decide the question? Very well, let us experiment. What do you suggest? I shall measure the amount of water that I can put into each bottle. The water will drive out the air and fill the air spaces. In this way we shall decide the question. Watch carefully. The BB shot represents the sand particles; the small shot takes the place of the clay. (Teacher experiments.) How do you account for the result? Yes, while the air spaces are smaller between the small shot than are those between the BB shot, there are many more of them, and hence there is more air space. Let us try the same experiment with these tubes full of clay and sand. (Whenever possible, create differences of opinion to be decided by experimentation. Let the children form the habit of meeting and solving new situations.)

Humus has fine texture. (With a flame of some kind, heat soil containing humus in a tin until it smolders.) Where have you noticed this odor before? What is humus? This soil came from beneath a tree. Where did the vegetable matter come from? Name other sources of humus.

The particles of humus are very fine. Which has the larger capillary tubes, humus or sand? How do you know?

Sand is warm; clay is cold. You have learned that clay holds more moisture than sand. Wet one finger. Why does it feel cool? Where is evaporation the greater, in sand or clay for a long period of time? Which is the cooler, clay or sand? Let us see. Feel of these samples of sand, clay, and humus, which have been in the sun. Describe the temperature of each. Test each with this thermometer to see whether your answers are correct.

Relative weights of sand, humus, and clay. Observe this bottle again. (Hold up bottle used in Exercise 1.) Which

is the heaviest, sand, humus, or clay? Which is the lightest? Sand is the heaviest in weight, but the lightest to work.

Improvement of soil. Sand is warm and light to work, but it is too loose. Clay is cold and heavy to work. Tell us how you would improve a sandy soil; a clayey soil. Here are piles of sand, clay, and humus. (Have a child come forward and mix the soils as the rest direct.) After mixing them and moistening we shall leave the piles until a later lesson and see whether our theories are true. (Have the children suggest mixing clay and sand, clay and humus, sand and humus, lime and clay.)

Summary. Tell all that you have learned about the characteristics of sand, clay, and of humus.

Assignment of lesson. For the next lesson study Chapter I in your agricultural text — *The Principles of Agriculture through the School and the Home Garden.* (The subject matter in the text in each instance is a review of the previous lesson as taught by the teacher. The lesson outlined in the teacher's manual should precede the corresponding chapter in the children's text. Either a whole period may be given to the following recitation, which should be enriched with new material, or a ten-minute oral quizz preceding the new lesson may suffice. Give careful attention to the "Home Studies.")

NOTE. — Have the class make physical tests of soils. These will, necessarily, be inaccurate, yet in the main helpful. Have the children estimate the percentage of clay, sand, and humus. Make a collection of soils.

80–100 % sand means sandy soil.
60– 80 % sand means sandy loam.
40– 60 % sand means loam.
20– 40 % sand means clayey loam.
0– 20 % sand means clay.

Reference Books

Soils. Hilgard. The Macmillan Co.

Soils. Burkett. Orange-Judd Co.

Soils. Roberts. The Macmillan Co.

The Soils. King. The Macmillan Co.

Books on General Agriculture.

Read to the children articles on the manufacture of glass, linen, etc.

Linen Made in America. World To-day. April, 1908.

History and Hygiene of Linen. Overland. November, 1902.

Glass-making. Cosmopolitan. June, 1904.

Manufacture of Cut Glass. Current Literature. October, 1902.

Manufacture of Glass. Science American. June, 1910.

Farmers' Bulletins

Send to the Secretary of Agriculture, Washington, D.C., for the Farmers' Bulletins listed in the following chapters. The bulletins are free. At the same time ask to have your name placed on the mailing list to receive the *Monthly List of Publications.*

Excellent bulletins are issued from the State Experiment Stations. A few of these are listed throughout the manual. Usually they may be had for the asking. Write to the Experiment Station in your state requesting a list of published bulletins. Also have your name added to the mailing list.

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